Jones

# Standard Steel Construction

A MANUAL FOR

## Architects, Engineers and Contractors

RELATING TO THE
USE OF

# Structural Steel

SEVENTH EDITION
1916

MANUFACTURED BY

## Jones & Laughlin Steel Company

AMERICAN IRON AND STEEL WORKS
Pittsburgh

PRICE $1.50

# Preface

## Seventh Edition

In order that Standard Steel Construction may present the latest development in the manufacture of steel shapes and their use in such constructional work as buildings, bridges, cars, ships and barges, the text has been completely rewritten for this edition.

The diagrams and tables include only the sections best suited for these types of steel construction. A complete list of all the sections that we roll, with diagrams and weight tables, is shown in our Shape Book.

Much new data in the way of general information useful to architects, engineers and contractors has been added.

In determining the arrangement and classification of data the natural sequence has been followed as nearly as practicable without losing sight of convenience in locating the subject sought. For this reason the several specifications for material and fabrication are placed at the end of the book.

# Offices

**General Offices**
**Pittsburgh**

**Branch Office and Warehouse**
**Chicago**

---

## District Sales Offices

**Boston**
131 State Street

**Buffalo**
White Building

**Cincinnati**
Union Trust Company Building

**Cleveland**
Rockefeller Building

**Detroit**
Penobscot Building

**New York**
165 Broadway

**Philadelphia**
Commercial Trust Building

**Pittsburgh**
Jones & Laughlin Building

**San Francisco**
Crocker Building

**St. Louis**
Pierce Building

# Plants

Eliza Furnaces and Coke Ovens

South Side Works

Soho Furnace and Works

Keystone Works

Aliquippa Works

# J & L Products

Billets  Blooms  Slabs  Skelp
Sheet Bars

Beams  Channels  Angles
Tees  Zees  Plates
Sheet Piling

Rounds  Squares  Flats  Hexagons
Ovals  Hoops  Bands

Special Shapes
Agricultural Shapes
Tie Plates

Bars for Concrete Reinforcement
Light Rails and Connections
Steel Mine Ties

## STRUCTURAL WORK

Columns  Girders  Trusses
Plate Work
Steel Barges

# J & L Products

Wire Wire Nails Wire Products

Tin Plate Black Sheets
(Tin Mill Sizes)

Railroad Spikes Rivets Boat Spikes

Chain

Power Transmission Machinery

## COLD ROLLED

Shafting Axles Shapes
Finger Bars

## COLD DRAWN

Hexagons Flats
Squares Rounds

## FORGINGS

## Suggestions in Reference to Ordering Material

In the Standard specifications of the American Society for Testing Materials will be noted what are termed the permissible variations in the rolling of plates, shapes and bars, and provision should be made in the design to care for such variations. A design which does not permit of this variation is frequently the cause of serious difficulties. Ample clearances tend toward ease and economy in fabrication and greater facility in the erection of any structure.

All the profiles and tables of sections in this book give the theoretical dimensions, to which we endeavor to work, but, owing to wear of rolls and other contingencies, we cannot guarantee that these profiles will be exactly reproduced in the sections. Wherever a profile applies to more than one weight of a section the dimensions given are for the minimum weight only.

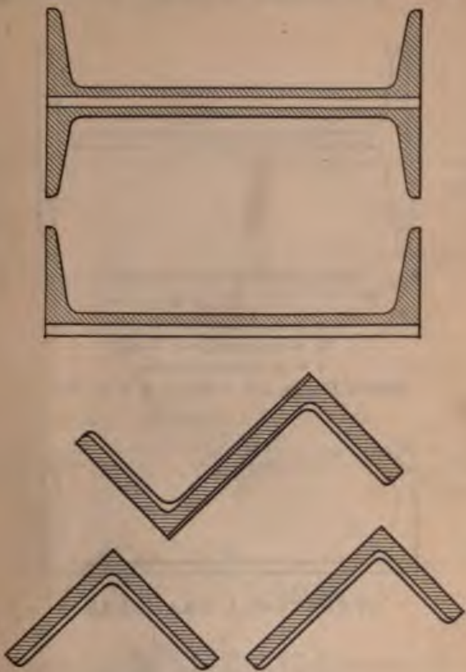
All weights, with the exception of rails, are given in pounds per lineal foot. The weights of rails are given in pounds per lineal yard. Where but one weight is specified for a section that weight only can be rolled.

Beams, channels, sheet piling, tees and zees should be ordered to weight per lineal foot. Angles should be ordered either to weight per foot or to thickness, but never both. For universal mill plates, there should be specified the width and the thickness, both in inches, the length being given in feet and inches. Sheared plates, on the other hand, should have all dimensions specified in inches. For round and square rods, also bars, the width and the thickness should be specified in inches, the length in feet and inches. For the sizes of rails that we make, it is sufficient to specify weight per yard. For miscellaneous sections always specify the section number.

The association of American Steel Manufacturers recommend that certain sections of angles be considered as standard for general building construction, ship, car and bridge work. These angles have been indicated by printing their index numbers in bold-faced type in the tables on the profile pages and it is generally to the advantage of the customer to specify these standard sizes wherever possible.

In ordering material to specified lengths, the usual allowances for over or under length vary from ¼″ to ½″ either way, and this should not be lost sight of in determining the lengths to order. *When more exact cutting is required special arrangements are necessary.*

# Method of Increasing Sectional Areas

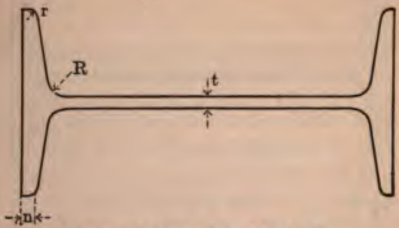


The above figures show the method of increasing the sectional areas and weights of structural shapes. Cross hatched portions represent the minimum sections and the blank portions the added areas.

In the case of Channels and I-Beams, the enlargement of the section adds an equal amount to the thickness of the web and the width of the flanges. In the case of Angles and Zees, the effect of spreading the rolls is slightly to increase the length of the legs. Many of the sizes, however, are rolled in finishing passes whereby the exact dimensions are maintained for different thicknesses.

Inasmuch, however, as these passes are modified in the wear of the rolls, it is impracticable to state what the exact dimensions will be, except in the case of the minimum weight sections. Designers and detailers of structural work should, therefore, arrange for ample clearances.

# Common Dimensions of Beams and Channels




**STRUCTURAL BEAMS**

n = minimum web = t
R = minimum web + 0.10
r = $\frac{6}{10}$ minimum web
Slope of Flange, 1:6 = 16⅔% = 9° 27′ 42″


**STRUCTURAL CHANNELS**

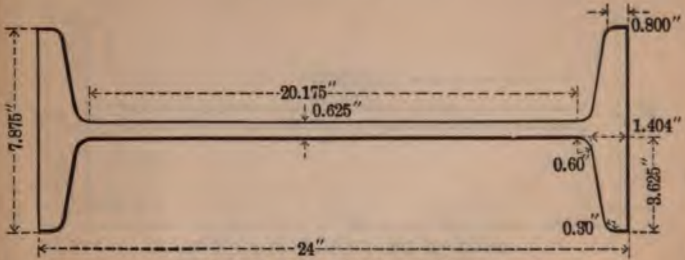
n = minimum web = t
R = minimum web + 0.10
r = $\frac{6}{10}$ minimum web
Slope of Flange, 1:6 = 16⅔% = 9° 27′ 42″

All dimensions are in inches and apply only to the minimum weight Beams or Channels.

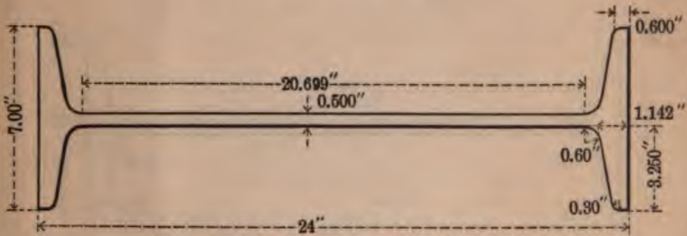
Dimensions given for Structural Beams are those adopted in 1896 by the Association of American Steel Manufacturers and apply to all Beam Sections shown on the pages which follow, except Beam Sections B0 to B7, B12 to B16, and B20 to B26.

Dimensions shown for structural Channels are those adopted by the Association of American Steel Manufacturers and apply to all Structural Channel Sections *except C12 to C19.*

# Structural Beams




**B-0 to B-2** 115, 110 and 105 lbs.

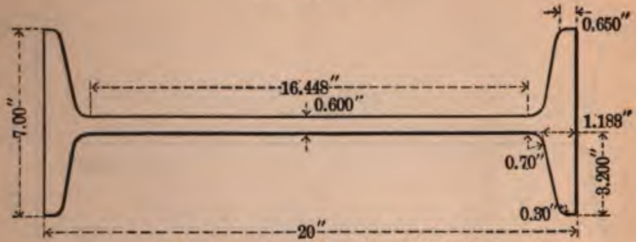



**B-3 to B-7** 100, 95, 90, 85 and 80 lbs.

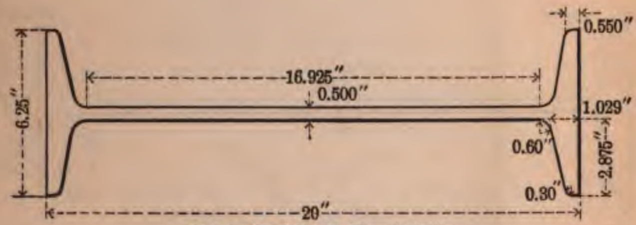
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-0 | | 115.0 | 8.000 | 8 | 0.750 | 3/4 | 47 |
| B-1 | 24 | 110.0 | 7.938 | 7 15/16 | 0.688 | 11/16 | 49 |
| B-2 | | 105.0 | 7.875 | 7 7/8 | 0.625 | 5/8 | 52 |
| B-3 | | 100.0 | 7.254 | 7 1/4 | 0.754 | 3/4 | 54 |
| B-4 | | 95.0 | 7.193 | 7 3/16 | 0.693 | 11/16 | 57 |
| B-5 | 24 | 90.0 | 7.131 | 7 1/8 | 0.631 | 5/8 | 60 |
| B-6 | | 85.0 | 7.070 | 7 1/16 | 0.570 | 9/16 | 64 |
| B-7 | | 80.0 | 7.000 | 7 | 0.500 | 1/2 | 6[illegible] |

# Structural Beams

**Continued**




**B-12—B-16** 100, 95, 90, 85 and 80 lbs.

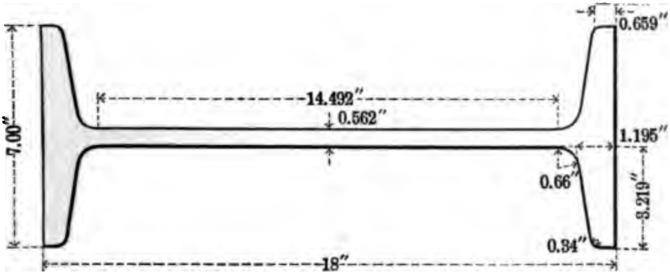



**B-20—B-22** 75, 70 and 65 lbs.

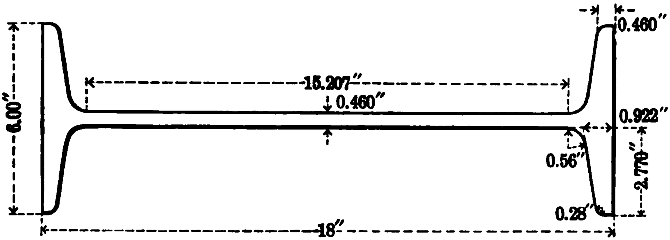
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-12 | 20 | 100.0 | 7.284 | $7\frac{9}{32}$ | 0.884 | $\frac{57}{64}$ | 46 |
| B-13 | | 95.0 | 7.210 | $7\frac{13}{64}$ | 0.810 | $\frac{13}{16}$ | 49 |
| B-14 | | 90.0 | 7.137 | $7\frac{9}{64}$ | 0.737 | $\frac{47}{64}$ | 52 |
| B-15 | | 85.0 | 7.063 | $7\frac{1}{16}$ | 0.663 | $\frac{21}{32}$ | 55 |
| B-16 | | 80.0 | 7.000 | 7 | 0.600 | $\frac{19}{32}$ | 57 |
| B-20 | 20 | 75.0 | 6.399 | $6\frac{13}{32}$ | 0.649 | $\frac{21}{32}$ | 61 |
| B-21 | | 70.0 | 6.325 | $6\frac{21}{64}$ | 0.575 | $\frac{37}{64}$ | 66 |
| *B-22* | | *65.0* | 6.250 | $6\frac{1}{4}$ | 0.500 | $\frac{1}{2}$ | 72 |

# Structural Beams

**Continued**




***B-23 to B-26** 90, 85, 80 and 75 lbs.



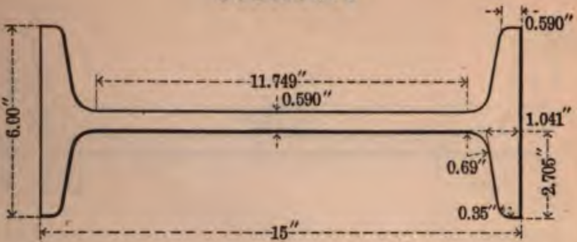

**B-27 to B-30** 70, 65, 60 and 55 lbs.

| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| *B-23 | 18 | 90.0 | 7.245 | 7 1/4 | 0.807 | 13/16 | 51 |
| *B-24 | | 85.0 | 7.163 | 7 5/32 | 0.725 | 23/32 | 54 |
| *B-25 | | 80.0 | 7.082 | 7 5/64 | 0.644 | 41/64 | 57 |
| *B-26 | | 75.0 | 7.000 | 7 | 0.562 | 9/16 | 61 |
| B-27 | 18 | 70.0 | 6.259 | 6 17/64 | 0.719 | 23/32 | 66 |
| B-28 | | 65.0 | 6.177 | 6 11/64 | 0.637 | 41/64 | 71 |
| B-29 | | 60.0 | 6.095 | 6 3/32 | 0.555 | 9/16 | 77 |
| B-30 | | 55.0 | 6.000 | 6 | 0.460 | 29/64 | 85 |

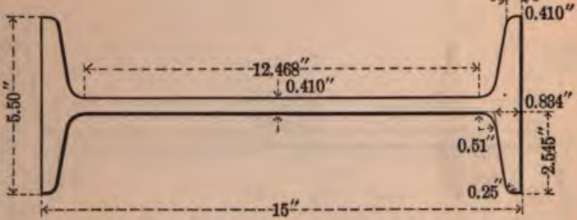
*Proposed Sections—Inserted for reference only.

# Structural Beams

**Continued**




**B-44—B-47** 75, 70, 65 and 60 lbs.

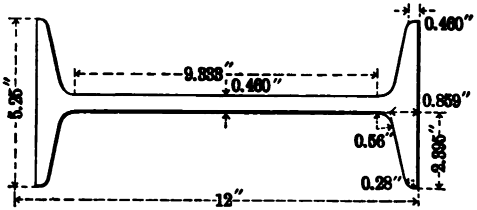



**B-52—B-55** 55, 50, 45 and 42 lbs.

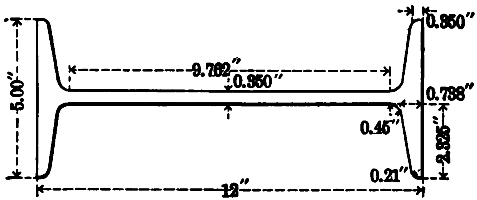
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-44 | 15 | 75.0 | 6.292 | $6\frac{19}{64}$ | 0.882 | $\frac{7}{8}$ | 55 |
| B-45 | | 70.0 | 6.194 | $6\frac{3}{16}$ | 0.784 | $\frac{25}{32}$ | 59 |
| B-46 | | 65.0 | 6.096 | $6\frac{3}{32}$ | 0.686 | $\frac{11}{16}$ | 63 |
| B-47 | | 60.0 | 6.000 | 6 | 0.590 | $\frac{19}{32}$ | 69 |
| B-52 | 15 | 55.0 | 5.746 | $5\frac{3}{4}$ | 0.656 | $\frac{21}{32}$ | 76 |
| B-53 | | 50.0 | 5.648 | $5\frac{41}{64}$ | 0.558 | $\frac{9}{16}$ | 84 |
| *B-54* | | *45.0* | 5.550 | $5\frac{35}{64}$ | 0.460 | $\frac{29}{64}$ | 93 |
| *B-55* | | *42.0* | 5.500 | $5\frac{1}{2}$ | 0.410 | $\frac{13}{32}$ | 95 |

# Structural Beams

**Continued**




**B-60—B-63** 55, 50, 45 and 40 lbs.

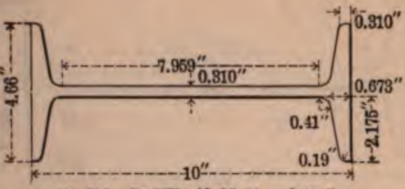



**B-68—B-69** 35 and 31.5 lbs.

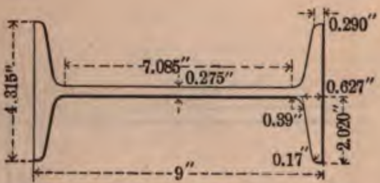
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-60 | 12 | 55.0 | 5.611 | $5\frac{39}{64}$ | 0.821 | $\frac{53}{64}$ | 54 |
| B-61 | | 50.0 | 5.489 | $5\frac{31}{64}$ | 0.699 | $\frac{45}{64}$ | 60 |
| B-62 | | 45.0 | 5.366 | $5\frac{23}{64}$ | 0.576 | $\frac{37}{64}$ | 64 |
| B-63 | | 40.0 | 5.250 | $5\frac{1}{4}$ | 0.460 | $\frac{29}{64}$ | 73 |
| B-68 | 12 | 35.0 | 5.086 | $5\frac{3}{32}$ | 0.436 | $\frac{7}{16}$ | 84 |
| B-69 | | 31.5 | 5.000 | 5 | 0.350 | $\frac{11}{32}$ | 84 |

# Structural Beams

**Continued**




**B-74—B-77** 40, 35, 30 and 25 lbs.

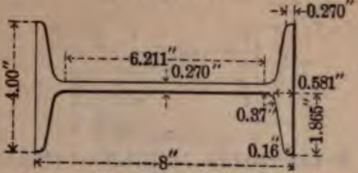



**B-82—B-85** 35, 30, 25 and 21 lbs.

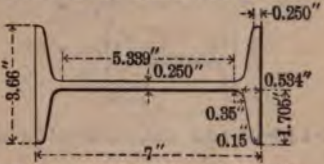
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-74 | 10 | 40.0 | 5.099 | $5\frac{3}{32}$ | 0.749 | $\frac{3}{4}$ | 80 |
| B-75 | | 35.0 | 4.952 | $4\frac{61}{64}$ | 0.602 | $\frac{39}{64}$ | 90 |
| B-76 | | 30.0 | 4.805 | $4\frac{13}{16}$ | 0.455 | $\frac{29}{64}$ | 100 |
| B-77 | | 25.0 | 4.660 | $4\frac{21}{32}$ | 0.310 | $\frac{5}{16}$ | 100 |
| B-82 | 9 | 35.0 | 4.772 | $4\frac{49}{64}$ | 0.732 | $\frac{47}{64}$ | 90 |
| B-83 | | 30.0 | 4.609 | $4\frac{39}{64}$ | 0.569 | $\frac{9}{16}$ | 100 |
| *B-84* | | 25.0 | 4.446 | $4\frac{29}{64}$ | 0.406 | $\frac{13}{32}$ | 100 |
| *B-85* | | *21.0* | 4.315 | $4\frac{5}{16}$ | 0.275 | $\frac{9}{32}$ | 100 |

# Structural Beams

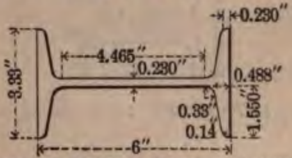
**Continued**




**B-90—B-93** 25.5, 23, 20.5 and 18 lbs.




**B-98—B-100** 20, 17.5 and 15 lbs.

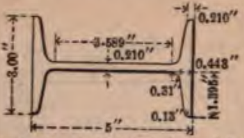



**B-105—B-107** 17.25, 14.75 and 12.25 lbs.

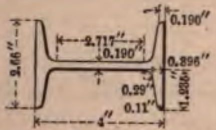
| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-90 | 8 | 25.5 | 4.271 | $4\frac{17}{64}$ | 0.541 | $\frac{35}{64}$ | 90 |
| B-91 | | 23.0 | 4.179 | $4\frac{11}{64}$ | 0.449 | $\frac{29}{64}$ | 100 |
| B-92 | | 20.5 | 4.087 | $4\frac{3}{32}$ | 0.357 | $\frac{23}{64}$ | 100 |
| B-93 | | 18.0 | 4.000 | 4 | 0.270 | $\frac{17}{64}$ | 100 |
| B-98 | 7 | 20 | 3.868 | $3\frac{7}{8}$ | 0.458 | $\frac{29}{64}$ | 90 |
| B-99 | | 17.5 | 3.763 | $3\frac{49}{64}$ | 0.353 | $\frac{23}{64}$ | 100 |
| B-100 | | 15.0 | 3.660 | $3\frac{21}{32}$ | 0.250 | $\frac{1}{4}$ | 100 |
| B-105 | 6 | 17.25 | 3.575 | $3\frac{37}{64}$ | 0.475 | $\frac{15}{32}$ | 90 |
| B-106 | | 14.75 | 3.452 | $3\frac{29}{64}$ | 0.352 | $\frac{23}{64}$ | 100 |
| *B-107* | | *12.25* | 3.330 | $3\frac{21}{64}$ | 0.230 | $\frac{15}{64}$ | 100 |

# Structural Beams

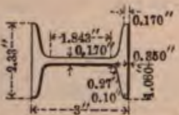
**Continued**




**B-112—B-114** 14.75, 12.25 and 9.75 lbs.



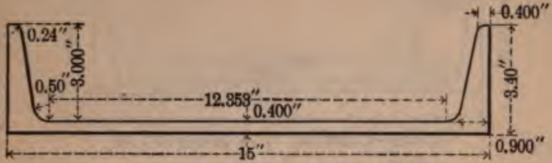

**B-119—B-122** 10.5, 9.5, 8.5 and 7.5 lbs.



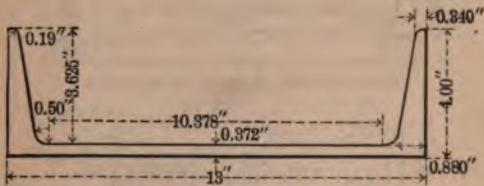

**B-127—B-129** 7.5, 6.5 and 5.5 lbs.

| Section Index | Depth of Beam, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| B-112 | | 14.75 | 3.294 | $3\frac{19}{64}$ | 0.504 | $\frac{1}{2}$ | 90 |
| B-113 | 5 | 12.25 | 3.147 | $3\frac{9}{64}$ | 0.357 | $\frac{23}{64}$ | 100 |
| B-114 | | 9.75 | 3.000 | 3 | 0.210 | $\frac{13}{64}$ | 100 |
| B-119 | | 10.5 | 2.880 | $2\frac{7}{8}$ | 0.410 | $\frac{13}{32}$ | 50 |
| B-120 | 4 | 9.5 | 2.807 | $2\frac{13}{16}$ | 0.337 | $\frac{11}{32}$ | 55 |
| B-121 | | 8.5 | 2.733 | $2\frac{47}{64}$ | 0.263 | $\frac{17}{64}$ | 65 |
| B-122 | | 7.5 | 2.660 | $2\frac{21}{32}$ | 0.190 | $\frac{3}{16}$ | 65 |
| B-127 | | 7.5 | 2.521 | $2\frac{33}{64}$ | 0.361 | $\frac{23}{64}$ | 33 |
| B-128 | 3 | 6.5 | 2.423 | $2\frac{27}{64}$ | 0.263 | $\frac{17}{64}$ | 38 |
| B-129 | | 5.5 | 2.330 | $2\frac{21}{64}$ | 0.170 | $\frac{11}{64}$ | 45 |

# Structural Channels




**C-3—C-8** 55, 50, 45, 40, 35 and 33 lbs.

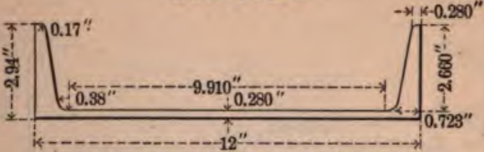



**C-12—C-19** 52.5, 50, 45, 40, 37.5, 35, 32 and 31.5 lbs.

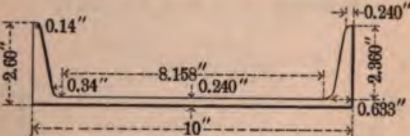
| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-3 | 15 | 55.0 | 3.818 | $3\frac{13}{16}$ | 0.818 | $\frac{13}{16}$ | 75 |
| C-4 | | 50.0 | 3.720 | $3\frac{23}{32}$ | 0.720 | $\frac{23}{32}$ | 84 |
| C-5 | | 45.0 | 3.622 | $3\frac{5}{8}$ | 0.622 | $\frac{5}{8}$ | 95 |
| C-6 | | 40.0 | 3.524 | $3\frac{17}{32}$ | 0.524 | $\frac{17}{32}$ | 95 |
| C-7 | | 35.0 | 3.426 | $3\frac{27}{64}$ | 0.426 | $\frac{27}{64}$ | 95 |
| C-8 | | 33.0 | 3.400 | $3\frac{13}{32}$ | 0.400 | $\frac{13}{32}$ | 95 |
| C-12 | 13 | 52.5 | 4.473 | $4\frac{15}{32}$ | 0.848 | $\frac{27}{32}$ | 61 |
| C-13 | | 50.0 | 4.416 | $4\frac{27}{64}$ | 0.791 | $\frac{51}{64}$ | 64 |
| C-14 | | 45.0 | 4.303 | $4\frac{19}{64}$ | 0.678 | $\frac{43}{64}$ | 72 |
| C-15 | | 40.0 | 4.190 | $4\frac{3}{16}$ | 0.565 | $\frac{9}{16}$ | 80 |
| C-16 | | 37.5 | 4.134 | $4\frac{9}{64}$ | 0.509 | $\frac{33}{64}$ | 86 |
| C-17 | | 35.0 | 4.077 | $4\frac{5}{64}$ | 0.452 | $\frac{29}{64}$ | 93 |
| C-18 | | *32.0* | 4.009 | $4\frac{1}{64}$ | 0.384 | $\frac{25}{64}$ | 95 |
| *C-19* | | *31.5* | 3.997 | 4 | 0.372 | $\frac{3}{8}$ | 95 |

# Structural Channels

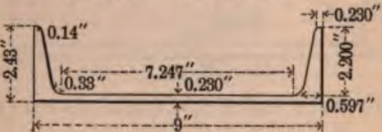
**Continued**




**C-23—C-27** 40, 35, 30, 25 and 20.5 lbs.




**C-32—C-36** 35, 30, 25, 20 and 15 lbs.

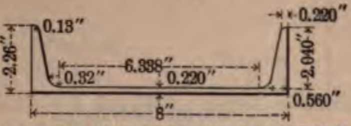



**C-41—C-44** 25, 20, 15 and 13.25 lbs.

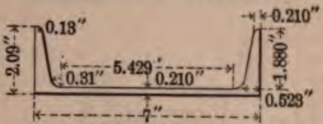
| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-23 | 12 | 40.0 | 3.418 | $3\frac{27}{64}$ | 0.758 | $\frac{49}{64}$ | 80 |
| C-24 | | 35.0 | 3.296 | $3\frac{19}{64}$ | 0.636 | $\frac{41}{64}$ | 89 |
| C-25 | | 30.0 | 3.173 | $3\frac{11}{64}$ | 0.513 | $\frac{33}{64}$ | 95 |
| C-26 | | 25.0 | 3.050 | $3\frac{3}{64}$ | 0.390 | $\frac{25}{64}$ | 95 |
| C-27 | | 20.5 | 2.940 | $2\frac{15}{16}$ | 0.280 | $\frac{9}{32}$ | 95 |
| C-32 | 10 | 35.0 | 3.183 | $3\frac{3}{16}$ | 0.823 | $\frac{53}{64}$ | 75 |
| C-33 | | 30.0 | 3.036 | $3\frac{1}{32}$ | 0.676 | $\frac{43}{64}$ | 85 |
| C-34 | | 25.0 | 2.889 | $2\frac{57}{64}$ | 0.529 | $\frac{17}{32}$ | 100 |
| C-35 | | 20.0 | 2.742 | $2\frac{47}{64}$ | 0.382 | $\frac{3}{8}$ | 100 |
| C-36 | | 15.0 | 2.600 | $2\frac{19}{32}$ | 0.240 | $\frac{15}{64}$ | 100 |
| *C-41* | *9* | *25.0* | 2.815 | $2\frac{13}{16}$ | 0.615 | $\frac{39}{64}$ | 75 |
| *C-42* | | *20.0* | 2.652 | $2\frac{21}{32}$ | 0.452 | $\frac{29}{64}$ | 85 |
| *C-43* | | *15.0* | 2.488 | $2\frac{31}{64}$ | 0.288 | $\frac{9}{32}$ | 100 |
| *C-44* | | *13.25* | 2.430 | $2\frac{7}{16}$ | 0.230 | $\frac{15}{64}$ | 100 |

# Structural Channels

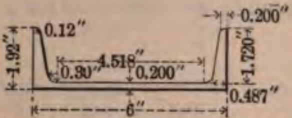
**Continued**




**C-49—C-53** 21.25, 18.75, 16.25, 13.75 and 11.25 lbs.




**C-58—C-62** 19.75, 17.25, 14.75, 12.25 and 9.75 lbs.

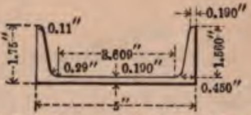



**C-67—C-70** 15.5, 13, 10.5 and 8 lbs.

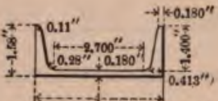
| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-49 | 8 | 21.25 | 2.622 | $2\frac{5}{8}$ | 0.582 | $\frac{37}{64}$ | 90 |
| C-50 | | 18.75 | 2.530 | $2\frac{17}{32}$ | 0.490 | $\frac{31}{64}$ | 100 |
| C-51 | | 16.25 | 2.439 | $2\frac{7}{16}$ | 0.399 | $\frac{13}{32}$ | 100 |
| C-52 | | 13.75 | 2.347 | $2\frac{11}{32}$ | 0.307 | $\frac{5}{16}$ | 100 |
| C-53 | | 11.25 | 2.260 | $2\frac{17}{64}$ | 0.220 | $\frac{7}{32}$ | 100 |
| C-58 | 7 | 19.75 | 2.513 | $2\frac{33}{64}$ | 0.633 | $\frac{41}{64}$ | 100 |
| C-59 | | 17.25 | 2.408 | $2\frac{13}{32}$ | 0.528 | $\frac{17}{32}$ | 100 |
| C-60 | | 14.75 | 2.303 | $2\frac{19}{64}$ | 0.423 | $\frac{27}{64}$ | 100 |
| C-61 | | 12.25 | 2.198 | $2\frac{13}{64}$ | 0.318 | $\frac{5}{16}$ | 100 |
| C-62 | | 9.75 | 2.090 | $2\frac{3}{32}$ | 0.210 | $\frac{13}{64}$ | 100 |
| C-67 | 6 | 15.5 | 2.283 | $2\frac{9}{32}$ | 0.563 | $\frac{9}{16}$ | 90 |
| C-68 | | 13.0 | 2.160 | $2\frac{5}{32}$ | 0.440 | $\frac{7}{16}$ | 100 |
| C-69 | | 10.5 | 2.038 | $2\frac{1}{32}$ | 0.318 | $\frac{5}{16}$ | 100 |
| C-70 | | 8.0 | 1.920 | $1\frac{59}{64}$ | 0.200 | $\frac{13}{64}$ | 100 |

# Structural Channels

**Continued**



**C-75—C-77** 11.5, 9 and 6.5 lbs.

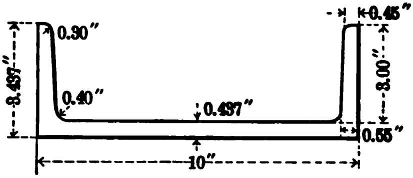


**C-82—C-84** 7.25, 6.25 and 5.25 lbs.

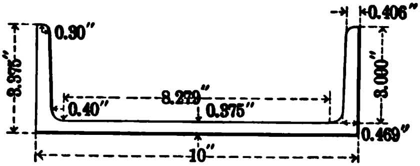
**C-89—C-91** 6, 5 and 4 lbs.

| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-75 | | 11.5 | 2.037 | $2\frac{1}{32}$ | 0.477 | $\frac{31}{64}$ | 65 |
| C-76 | 5 | 9.0 | 1.890 | $1\frac{57}{64}$ | 0.330 | $\frac{21}{64}$ | 65 |
| C-77 | | 6.5 | 1.750 | $1\frac{3}{4}$ | 0.190 | $\frac{3}{16}$ | 65 |
| C-82 | | 7.25 | 1.725 | $1\frac{23}{32}$ | 0.325 | $\frac{21}{64}$ | 65 |
| C-83 | 4 | 6.25 | 1.652 | $1\frac{21}{32}$ | 0.252 | $\frac{1}{4}$ | 65 |
| C-84 | | 5.25 | 1.580 | $1\frac{37}{64}$ | 0.180 | $\frac{3}{16}$ | 65 |
| C-89 | | 6.0 | 1.602 | $1\frac{39}{64}$ | 0.362 | $\frac{23}{64}$ | 42 |
| C-90 | 3 | 5.0 | 1.504 | $1\frac{1}{2}$ | 0.264 | $\frac{17}{64}$ | 50 |
| C-91 | | 4.0 | 1.410 | $1\frac{13}{32}$ | 0.170 | $\frac{11}{64}$ | 50 |

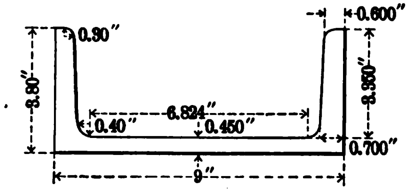
# Ship Building Channels




**C-101—C-102** 27.2 and 25 lbs.




**C-105** 21.8 lbs.



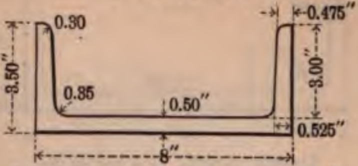

***C-107 to C-109**

| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-101 | 10 | 27.2 | 3.500 | 3½ | 0.500 | ½ | 95 |
| C-102 | | 25.0 | 3.437 | 3 7/16 | 0.437 | 7/16 | 95 |
| C-105 | 10 | 21.8 | 3.375 | 3⅜ | 0.375 | ⅜ | 95 |
| *C-107 | | 34.7 | 4.000 | 4 | 0.650 | 21/32 | 85 |
| *C-108 | 9 | 31.7 | 3.900 | 3 29/32 | 0.550 | 35/64 | 85 |
| *C-109 | | 28.6 | 3.800 | 3 51/64 | 0.450 | 29/64 | 85 |

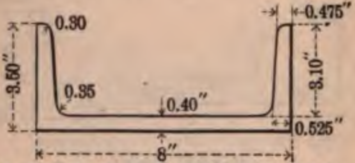
**Proposed Sections*—Inserted for reference only.

# Ship Building Channels

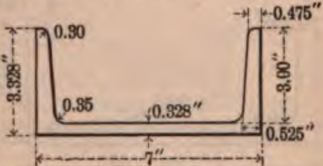
**Continued**




**C-114 to C-116** 26.5, 25.2 and 23.8 lbs.




**C-117 to C-119** 24.2, 22.8 and 21.4 lbs.

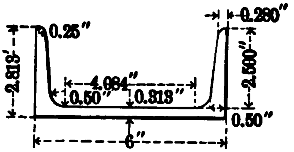



**C-121 to C-123** 22.1, 20 and 18 lbs.

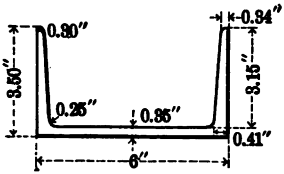
| Section Index | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| C-114 | | 26.5 | 3.600 | $3\frac{19}{32}$ | 0.600 | $\frac{19}{32}$ | 85 |
| C-115 | 8 | 25.2 | 3.550 | $3\frac{35}{64}$ | 0.550 | $\frac{35}{64}$ | 85 |
| C-116 | | 23.8 | 3.500 | $3\frac{1}{2}$ | 0.500 | $\frac{1}{2}$ | 90 |
| C-117 | | 24.2 | 3.600 | $3\frac{19}{32}$ | 0.500 | $\frac{1}{2}$ | 90 |
| C-118 | 8 | 22.8 | 3.550 | $3\frac{35}{64}$ | 0.450 | $\frac{29}{64}$ | 95 |
| C-119 | | 21.4 | 3.500 | $3\frac{1}{2}$ | 0.400 | $\frac{13}{32}$ | 100 |
| *C-121* | | *22.1* | 3.500 | $3\frac{1}{2}$ | 0.500 | $\frac{1}{2}$ | 75 |
| *C-122* | *7* | *20.0* | 3.412 | $3\frac{13}{32}$ | 0.412 | $\frac{13}{32}$ | 85 |
| *C-123* | | *18.0* | 3.328 | $3\frac{21}{64}$ | 0.328 | $\frac{21}{64}$ | 95 |

# Ship Building Channels

**Continued**



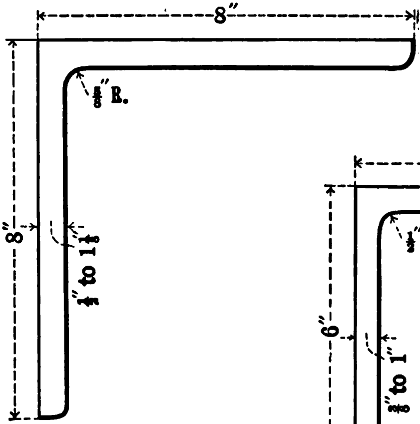

**C-128 to C-132** 18.1, 16.8, 15.6, 14.3 and 13.0 lbs.



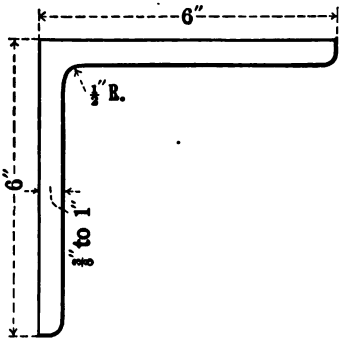

**C-137** 15 lbs.

| ction ndex | Depth of Channel, Inches | Weight per Foot, Pounds | Flange Width, Inches | | Web Thickness, Inches | | Maximum Length, Feet |
|---|---|---|---|---|---|---|---|
| | | | Decimal | Fractional | Decimal | Fractional | |
| -128 | | 18.1 | 3.063 | $3\frac{1}{16}$ | 0.563 | $\frac{9}{16}$ | 30 |
| -129 | | 16.8 | 3.000 | 3 | 0.500 | $\frac{1}{2}$ | 30 |
| -130 | 6 | 15.6 | 2.936 | $2\frac{15}{16}$ | 0.437 | $\frac{7}{16}$ | 35 |
| -131 | | 14.3 | 2.874 | $2\frac{7}{8}$ | 0.375 | $\frac{3}{8}$ | 35 |
| -132 | | 13.0 | 2.813 | $2\frac{13}{16}$ | 0.313 | $\frac{5}{16}$ | 40 |
| -137 | 6 | 15.0 | 3.500 | $3\frac{1}{2}$ | 0.350 | $\frac{11}{32}$ | 100 |

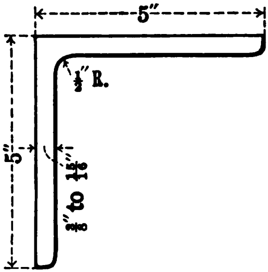
# Angles With Equal Legs



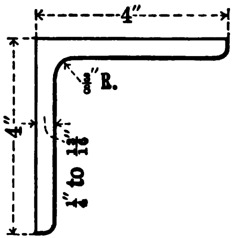

**A-3 to A-13** 56.9 to 26.4 lbs.




**A-17 to A-27** 37.4 to 14.9 lbs.




**A-33 to A-42** 28.9 to 12.3 lbs.




**A-47 to A-56** 19.9 to 6.6 lbs.

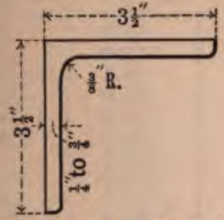
## Angles With Equal Legs

| Section Index | Size, Inches | Thickness, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|
| **A- 3** | 8 x 8 | $1\frac{1}{8}$ | 56.9 | 78 |
| **A- 4** | 8 x 8 | $1\frac{1}{16}$ | 54.0 | 83 |
| **A- 5** | 8 x 8 | 1 | 51.0 | 87 |
| **A- 6** | 8 x 8 | $\frac{15}{16}$ | 48.1 | 95 |
| **A- 7** | 8 x 8 | $\frac{7}{8}$ | 45.0 | 95 |
| **A- 8** | 8 x 8 | $\frac{13}{16}$ | 42.0 | 95 |
| **A- 9** | 8 x 8 | $\frac{3}{4}$ | 38.9 | 95 |
| **A-10** | 8 x 8 | $\frac{11}{16}$ | 35.8 | 95 |
| **A-11** | 8 x 8 | $\frac{5}{8}$ | 32.7 | 95 |
| **A-12** | 8 x 8 | $\frac{9}{16}$ | 29.6 | 95 |
| **A-13** | 8 x 8 | $\frac{1}{2}$ | 26.4 | 95 |
| **A-17** | 6 x 6 | 1 | 37.4 | 100 |
| **A-18** | 6 x 6 | $\frac{15}{16}$ | 35.3 | 100 |
| **A-19** | 6 x 6 | $\frac{7}{8}$ | 33.1 | 100 |
| **A-20** | 6 x 6 | $\frac{13}{16}$ | 31.0 | 100 |
| **A-21** | 6 x 6 | $\frac{3}{4}$ | 28.7 | 100 |
| **A-22** | 6 x 6 | $\frac{11}{16}$ | 26.5 | 100 |
| **A-23** | 6 x 6 | $\frac{5}{8}$ | 24.2 | 100 |
| **A-24** | 6 x 6 | $\frac{9}{16}$ | 21.9 | 100 |
| **A-25** | 6 x 6 | $\frac{1}{2}$ | 19.6 | 100 |
| **A-26** | 6 x 6 | $\frac{7}{16}$ | 17.2 | 100 |
| **A-27** | 6 x 6 | $\frac{3}{8}$ | 14.9 | 100 |
| A-33 | 5 x 5 | $\frac{15}{16}$ | 28.9 | 100 |
| A-34 | 5 x 5 | $\frac{7}{8}$ | 27.2 | 100 |
| A-35 | 5 x 5 | $\frac{13}{16}$ | 25.4 | 100 |
| A-36 | 5 x 5 | $\frac{3}{4}$ | 23.6 | 100 |
| A-37 | 5 x 5 | $\frac{11}{16}$ | 21.8 | 100 |
| A-38 | 5 x 5 | $\frac{5}{8}$ | 20.0 | 100 |
| A-39 | 5 x 5 | $\frac{9}{16}$ | 18.1 | 100 |
| A-40 | 5 x 5 | $\frac{1}{2}$ | 16.2 | 100 |
| A-41 | 5 x 5 | $\frac{7}{16}$ | 14.3 | 100 |
| A-42 | 5 x 5 | $\frac{3}{8}$ | 12.3 | 100 |
| A-47 | 4 x 4 | $\frac{13}{16}$ | 19.9 | 50 |
| **A-48** | 4 x 4 | $\frac{3}{4}$ | 18.5 | 52 |
| **A-49** | 4 x 4 | $\frac{11}{16}$ | 17.1 | 56 |
| **A-50** | 4 x 4 | $\frac{5}{8}$ | 15.7 | 61 |
| **A-51** | 4 x 4 | $\frac{9}{16}$ | 14.3 | 65 |
| **A-52** | 4 x 4 | $\frac{1}{2}$ | 12.8 | 65 |
| **A-53** | 4 x 4 | $\frac{7}{16}$ | 11.3 | 65 |
| **A-54** | 4 x 4 | $\frac{3}{8}$ | 9.8 | 65 |
| **A-55** | 4 x 4 | $\frac{5}{16}$ | 8.2 | 65 |
| *A-56* | *4 x 4* | $\frac{1}{4}$ | 6.6 | 65 |

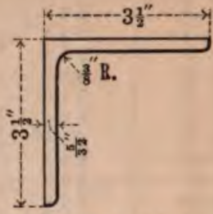
*Sections appearing in bold-face type adopted as standard by the Association of erican Steel Manufacturers for bridge, car, ship and general building c ction.*

# Angles With Equal Legs

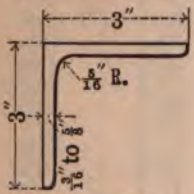
**Continued**



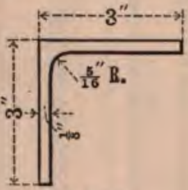

**A-62 to A-70** 16.0 to 5.8 lbs.



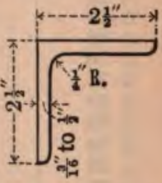

**A-75** 3.64 lbs.



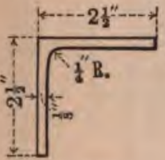

**A-98 to A-105**
11.5 to 3.71 lbs.




**A-110**
2.50 lbs.

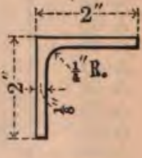



**A-130 to 135**
7.7 to 3.07 lbs.

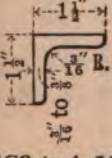



**A-140**
2.08 lbs.

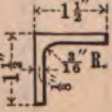

**A-160 to A-165**
6.0 to 2.44 lbs.




**A-170**
1.65 lbs.




***A-189 to A-192***
*3.35 to 1.80 lbs.*




**A-197**
1.23 lbs.

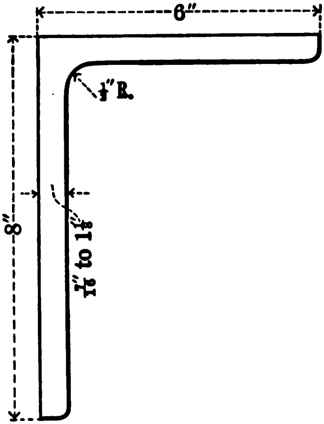

**A-224 to A-226**
1.49 to 0.80 lbs.

# Angles With Equal Legs

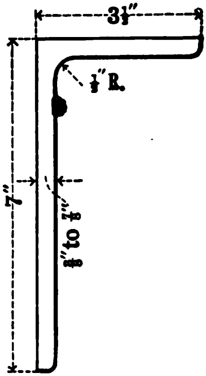
### Continued

| Section Index | Size, Inches | Thickness, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|
| A- 62 | 3½ x 3½ | ¾ | 16.0 | 50 |
| A- 63 | 3½ x 3½ | $\frac{11}{16}$ | 14.8 | 54 |
| **A- 64** | 3½ x 3½ | ⅝ | 13.6 | 60 |
| **A- 65** | 3½ x 3½ | $\frac{9}{16}$ | 12.4 | 65 |
| **A- 66** | 3½ x 3½ | ½ | 11.1 | 65 |
| **A- 67** | 3½ x 3½ | $\frac{7}{16}$ | 9.8 | 65 |
| **A- 68** | 3½ x 3½ | ⅜ | 8.5 | 65 |
| **A- 69** | 3½ x 3½ | $\frac{5}{16}$ | 7.2 | 65 |
| A- 70 | 3½ x 3½ | ¼ | 5.8 | 65 |
| A- 75 | 3½ x 3½ | $\frac{5}{32}$ | 3.64 | 45 |
| A- 98 | 3 x 3 | ⅝ | 11.5 | 50 |
| A- 99 | 3 x 3 | $\frac{9}{16}$ | 10.4 | 55 |
| **A-100** | 3 x 3 | ½ | 9.4 | 60 |
| **A-101** | 3 x 3 | $\frac{7}{16}$ | 8.3 | 65 |
| **A-102** | 3 x 3 | ⅜ | 7.2 | 65 |
| **A-103** | 3 x 3 | $\frac{5}{16}$ | 6.1 | 65 |
| **A-104** | 3 x 3 | ¼ | 4.9 | 65 |
| A-105 | 3 x 3 | $\frac{3}{16}$ | 3.71 | 45 |
| A-110 | 3 x 3 | ⅛ | 2.50 | 40 |
| A-130 | 2½ x 2½ | ½ | 7.7 | 31 |
| **A-131** | 2½ x 2½ | $\frac{7}{16}$ | 6.8 | 35 |
| **A-132** | 2½ x 2½ | ⅜ | 5.9 | 40 |
| **A-133** | 2½ x 2½ | $\frac{5}{16}$ | 5.0 | 50 |
| **A-134** | 2½ x 2½ | ¼ | 4.1 | 50 |
| **A-135** | 2½ x 2½ | $\frac{3}{16}$ | 3.07 | 50 |
| A-140 | 2½ x 2½ | ⅛ | 2.08 | 50 |
| A-160 | 2 x 2 | ½ | 6.0 | 45 |
| A-161 | 2 x 2 | $\frac{7}{16}$ | 5.3 | 45 |
| **A-162** | 2 x 2 | ⅜ | 4.7 | 45 |
| **A-163** | 2 x 2 | $\frac{5}{16}$ | 3.92 | 50 |
| **A-164** | 2 x 2 | ¼ | 3.19 | 50 |
| **A-165** | 2 x 2 | $\frac{3}{16}$ | 2.44 | 50 |
| A-170 | 2 x 2 | ⅛ | 1.65 | 50 |
| A-189 | 1½ x 1½ | ⅜ | 3.35 | 35 |
| **A-190** | 1½ x 1½ | $\frac{5}{16}$ | 2.86 | 35 |
| **A-191** | 1½ x 1½ | ¼ | 2.34 | 35 |
| **A-192** | 1½ x 1½ | $\frac{3}{16}$ | 1.80 | 35 |
| **A-197** | 1½ x 1½ | ⅛ | 1.23 | 35 |
| A-224 | 1 x 1 | ¼ | 1.49 | 45 |
| A-225 | 1 x 1 | $\frac{3}{16}$ | 1.16 | 45 |
| A-226 | 1 x 1 | ⅛ | .80 | 45 |

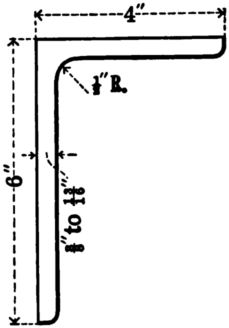
# Angles With Unequal Legs



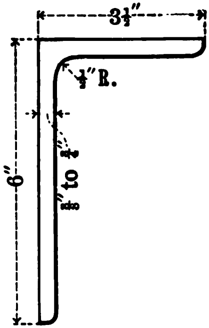

**A-233 to A-243**
49.3 to 23.0 lbs.
**A-650** 20.2 lbs.




**A-244 to A-252**
28.7 to 13.0 lbs.




***A-258 to A-265***
*25.4 to 12.3 lbs.*




**A-274 to A-280**
22.4 to 11.7 lbs.

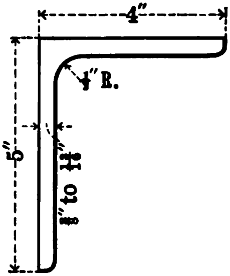
# Angles With Unequal Legs

| Section Index | Size, Inches | Thickness, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|
| A-233 | 8 x 6 | 1⅛ | 49.3 | 80 |
| A-234 | 8 x 6 | 1 1/16 | 46.8 | 85 |
| A-235 | 8 x 6 | 1 | 44.2 | 90 |
| A-236 | 8 x 6 | 15/16 | 41.7 | 95 |
| A-237 | 8 x 6 | ⅞ | 39.1 | 95 |
| A-238 | 8 x 6 | 13/16 | 36.5 | 95 |
| A-239 | 8 x 6 | ¾ | 33.8 | 95 |
| A-240 | 8 x 6 | 11/16 | 31.2 | 95 |
| A-241 | 8 x 6 | ⅝ | 28.5 | 95 |
| A-242 | 8 x 6 | 9/16 | 25.7 | 95 |
| A-243 | 8 x 6 | ½ | 23.0 | 95 |
| A-650 | 8 x 6 | 7/16 | 20.2 | 95 |
| A-244 | 7 x 3½ | ⅞ | 28.7 | 79 |
| A-245 | 7 x 3½ | 13/16 | 26.8 | 86 |
| A-246 | 7 x 3½ | ¾ | 24.9 | 95 |
| A-247 | 7 x 3½ | 11/16 | 23.0 | 95 |
| A-248 | 7 x 3½ | ⅝ | 21.0 | 95 |
| A-249 | 7 x 3½ | 9/16 | 19.1 | 95 |
| A-250 | 7 x 3½ | ½ | 17.0 | 95 |
| A-251 | 7 x 3½ | 7/16 | 15.0 | 95 |
| A-252 | 7 x 3½ | ⅜ | 13.0 | 95 |
| **A-258** | 6 x 4 | 13/16 | 25.4 | 90 |
| **A-259** | 6 x 4 | ¾ | 23.6 | 100 |
| **A-260** | 6 x 4 | 11/16 | 21.8 | 100 |
| **A-261** | 6 x 4 | ⅝ | 20.0 | 100 |
| **A-262** | 6 x 4 | 9/16 | 18.1 | 100 |
| **A-263** | 6 x 4 | ½ | 16.2 | 100 |
| **A-264** | 6 x 4 | 7/16 | 14.3 | 100 |
| **A-265** | 6 x 4 | ⅜ | 12.3 | 100 |
| **A-274** | 6 x 3½ | ¾ | 22.4 | 95 |
| **A-275** | 6 x 3½ | 11/16 | 20.6 | 100 |
| **A-276** | 6 x 3½ | ⅝ | 18.9 | 100 |
| **A-277** | 6 x 3½ | 9/16 | 17.1 | 100 |
| **A-278** | 6 x 3½ | ½ | 15.3 | 100 |
| **A-279** | 6 x 3½ | 7/16 | 13.5 | 100 |
| **A-280** | 6 x 3½ | ⅜ | 11.7 | 100 |

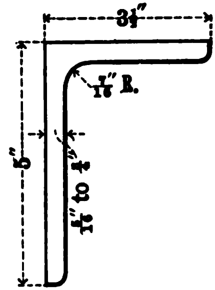
*Sections appearing* in bold-face type adopted as standard by the Association of *American Steel* Manufacturers, for bridge, car, ship and general building con-*struction.*

# Angles With Unequal Legs

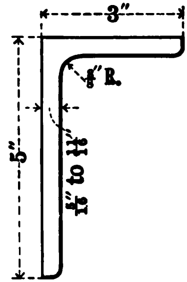
**Continued**



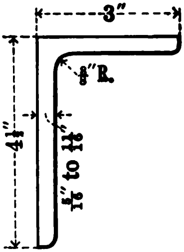

**A-286 to A-293**
**22.7 to 11.0 lbs.**



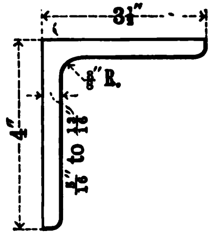

**A-300 to A-307**
**19.8 to 8.7 lbs.**




**A-315 to A-321**
**17.1 to 8.2 lbs.**




***A-328 to A-334***
***16.0 to 7.7 lbs.***




**A-339 to A-347**
**18.5 to 7.7 lbs.**

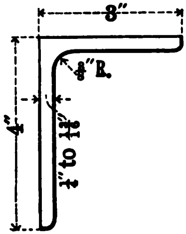
# Angles With Unequal Legs

Continued

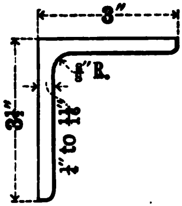
| Section Index | Size, Inches | Thickness, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|
| A-286 | 5 x 4 | 13/16 | 22.7 | 68 |
| A-287 | 5 x 4 | 3/4 | 21.1 | 75 |
| A-288 | 5 x 4 | 11/16 | 19.5 | 82 |
| A-289 | 5 x 4 | 5/8 | 17.8 | 90 |
| A-290 | 5 x 4 | 9/16 | 16.2 | 100 |
| A-291 | 5 x 4 | 1/2 | 14.5 | 100 |
| A-292 | 5 x 4 | 7/16 | 12.8 | 100 |
| A-293 | 5 x 4 | 3/8 | 11.0 | 100 |
| **A-300** | 5 x 3½ | 3/4 | 19.8 | 80 |
| **A-301** | 5 x 3½ | 11/16 | 18.3 | 87 |
| **A-302** | 5 x 3½ | 5/8 | 16.8 | 90 |
| **A-303** | 5 x 3½ | 9/16 | 15.2 | 100 |
| **A-304** | 5 x 3½ | 1/2 | 13.6 | 100 |
| **A-305** | 5 x 3½ | 7/16 | 12.0 | 100 |
| **A-306** | 5 x 3½ | 3/8 | 10.4 | 100 |
| **A-307** | 5 x 3½ | 5/16 | 8.7 | 100 |
| **A-315** | 5 x 3 | 11/16 | 17.1 | 90 |
| **A-316** | 5 x 3 | 5/8 | 15.7 | 97 |
| **A-317** | 5 x 3 | 9/16 | 14.3 | 100 |
| **A-318** | 5 x 3 | 1/2 | 12.8 | 100 |
| **A-319** | 5 x 3 | 7/16 | 11.3 | 100 |
| **A-320** | 5 x 3 | 3/8 | 9.8 | 100 |
| **A-321** | 5 x 3 | 5/16 | 8.2 | 100 |
| A-328 | 4½ x 3 | 11/16 | 16.0 | 50 |
| A-329 | 4½ x 3 | 5/8 | 14.7 | 54 |
| A-330 | 4½ x 3 | 9/16 | 13.3 | 60 |
| A-331 | 4½ x 3 | 1/2 | 11.9 | 65 |
| A-332 | 4½ x 3 | 7/16 | 10.6 | 65 |
| A-333 | 4½ x 3 | 3/8 | 9.1 | 65 |
| A-334 | 4½ x 3 | 5/16 | 7.7 | 65 |
| A-339 | 4 x 3½ | 13/16 | 18.5 | 44 |
| A-340 | 4 x 3½ | 3/4 | 17.3 | 46 |
| A-341 | 4 x 3½ | 11/16 | 16.0 | 50 |
| A-342 | 4 x 3½ | 5/8 | 14.7 | 54 |
| A-343 | 4 x 3½ | 9/16 | 13.3 | 60 |
| A-344 | 4 x 3½ | 1/2 | 11.9 | 65 |
| A-345 | 4 x 3½ | 7/16 | 10.6 | 65 |
| A-346 | 4 x 3½ | 3/8 | 9.1 | 65 |
| A-347 | 4 x 3½ | 5/16 | 7.7 | 65 |

# Angles With Unequal Legs

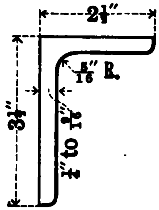
**Continued**



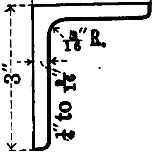

**A-354 to A-361**
14.8 to 5.8 lbs.



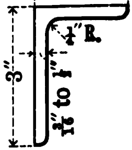

**A-365 to A-372**
13.6 to 5.4 lbs.



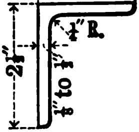
**A-379 to A-384**
10.4 to 4.9 lbs.




**A-405 to A-410**
9.5 to 4.5 lbs.




**A-415 to A-420**
7.7 to 3.07 lbs.



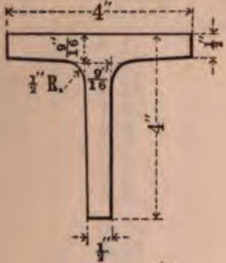

**A-425 to A-431**
6.8 to 1.86 lbs.

# Angles With Unequal Legs

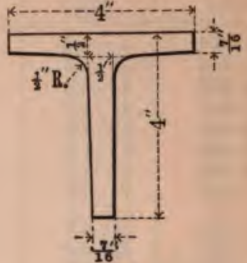
**Continued**

| Section Index | Size, Inches | Thickness, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|
| A-354 | 4 x 3 | 11/16 | 14.8 | 54 |
| A-355 | 4 x 3 | 5/8 | 13.6 | 60 |
| A-356 | 4 x 3 | 9/16 | 12.4 | 65 |
| A-357 | 4 x 3 | 1/2 | 11.1 | 65 |
| A-358 | 4 x 3 | 7/16 | 9.8 | 65 |
| A-359 | 4 x 3 | 3/8 | 8.5 | 65 |
| A-360 | 4 x 3 | 5/16 | 7.2 | 65 |
| A-361 | 4 x 3 | 1/4 | 5.8 | 65 |
| A-365 | 3½ x 3 | 11/16 | 13.6 | 40 |
| A-366 | 3½ x 3 | 5/8 | 12.5 | 44 |
| A-367 | 3½ x 3 | 9/16 | 11.4 | 48 |
| A-368 | 3½ x 3 | 1/2 | 10.2 | 50 |
| A-369 | 3½ x 3 | 7/16 | 9.1 | 55 |
| A-370 | 3½ x 3 | 3/8 | 7.9 | 60 |
| A-371 | 3½ x 3 | 5/16 | 6.6 | 65 |
| A-372 | 3½ x 3 | 1/4 | 5.4 | 65 |
| A-379 | 3½ x 2½ | 9/16 | 10.4 | 50 |
| A-380 | 3½ x 2½ | 1/2 | 9.4 | 54 |
| A-381 | 3½ x 2½ | 7/16 | 8.3 | 65 |
| A-382 | 3½ x 2½ | 3/8 | 7.2 | 65 |
| A-383 | 3½ x 2½ | 5/16 | 6.1 | 65 |
| A-384 | 3½ x 2½ | 1/4 | 4.9 | 65 |
| A-405 | 3 x 2½ | 9/16 | 9.5 | 55 |
| A-406 | 3 x 2½ | 1/2 | 8.5 | 65 |
| A-407 | 3 x 2½ | 7/16 | 7.6 | 65 |
| A-408 | 3 x 2½ | 3/8 | 6.6 | 65 |
| A-409 | 3 x 2½ | 5/16 | 5.6 | 65 |
| A-410 | 3 x 2½ | 1/4 | 4.5 | 65 |
| A-415 | 3 x 2 | 1/2 | 7.7 | 31 |
| A-416 | 3 x 2 | 7/16 | 6.8 | 35 |
| A-417 | 3 x 2 | 3/8 | 5.9 | 40 |
| A-418 | 3 x 2 | 5/16 | 5.0 | 50 |
| A-419 | 3 x 2 | 1/4 | 4.1 | 50 |
| A-420 | 3 x 2 | 3/16 | 3.07 | 50 |
| A-425 | 2½ x 2 | 1/2 | 6.8 | 35 |
| A-426 | 2½ x 2 | 7/16 | 6.1 | 45 |
| A-427 | 2½ x 2 | 3/8 | 5.3 | 45 |
| A-428 | 2½ x 2 | 5/16 | 4.5 | 50 |
| A-429 | 2½ x 2 | 1/4 | 3.62 | 50 |
| A-430 | 2½ x 2 | 3/16 | 2.75 | 50 |
| A-431 | 2½ x 2 | 1/8 | 1.86 | [illegible] |

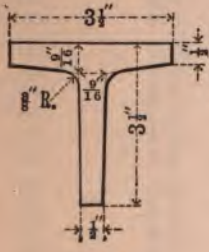
# Tees With Equal Legs



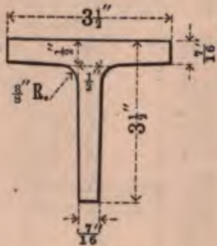
**T-3**
13.5 lbs.



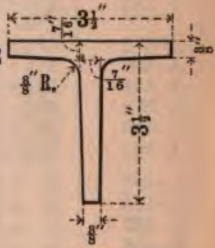
**T-4**
12.1 lbs.



**T-8**
11.9 lbs.



**T-9**
10.5 lbs.

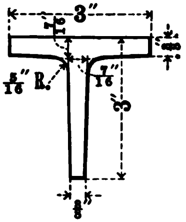


**T-10**
9.2 lbs.

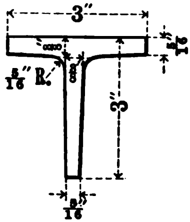
| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| T- 3 | 4 | 4 | ½ to $\frac{9}{16}$ | ½ to $\frac{9}{16}$ | 13.5 | 40 |
| T- 4 | 4 | 4 | $\frac{7}{16}$ to ½ | $\frac{7}{16}$ to ½ | 12.1 | 40 |
| T- 8 | 3½ | 3½ | ½ to $\frac{9}{16}$ | ½ to $\frac{9}{16}$ | 11.9 | 40 |
| *T- 9* | *3½* | *3½* | $\frac{7}{16}$ to ½ | $\frac{7}{16}$ to ½ | 10.5 | 40 |
| *T-10* | *3½* | *3½* | ⅜ to $\frac{7}{16}$ | ⅜ to $\frac{7}{16}$ | 9.2 | 40 |

# Tees With Equal Legs

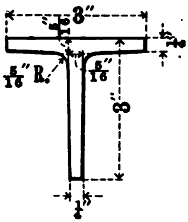
**Continued**



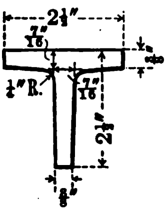

**T-15**
7.8 lbs.



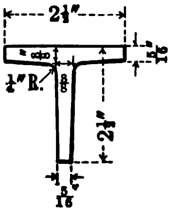

**T-16**
6.7 lbs.



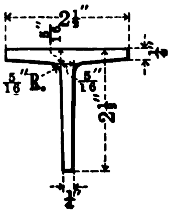

**T-17**
5.5 lbs.




**T-22**
6.4 lbs.




**T-23**
5.5 lbs.

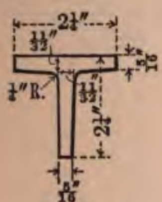



**T-24**
4.6 lbs.

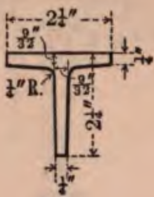
| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| T-15 | 3 | 3 | ⅜ to $\frac{7}{16}$ | ⅜ to $\frac{7}{16}$ | 7.8 | 40 |
| T-16 | 3 | 3 | $\frac{5}{16}$ to ⅜ | $\frac{5}{16}$ to ⅜ | 6.7 | 40 |
| T-17 | 3 | 3 | ¼ to $\frac{5}{16}$ | ¼ to $\frac{5}{16}$ | 5.5 | 40 |
| T-22 | 2½ | 2½ | ⅜ to $\frac{7}{16}$ | ⅜ to $\frac{7}{16}$ | 6.4 | 40 |
| T-23 | 2½ | 2½ | $\frac{5}{16}$ to ⅜ | $\frac{5}{16}$ to ⅜ | 5.5 | 45 |
| T-24 | 2½ | 2½ | ¼ to $\frac{5}{16}$ | ¼ to $\frac{5}{16}$ | 4.6 | 50 |

# Tees With Equal Legs

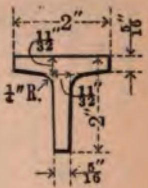
**Continued**



**T-28**
4.7 lbs.



**T-29**
3.83 lbs.



**T-33**
4.1 lbs.

**T-34**
3.38 lbs.

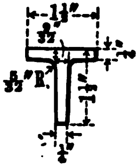
**T-39**
2.93 lbs.

**T-40**
2.28 lbs.

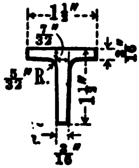
| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| T-28 | 2¼ | 2¼ | $\frac{5}{16}$ to $\frac{11}{32}$ | $\frac{5}{16}$ to $\frac{11}{32}$ | 4.7 | 50 |
| T-29 | 2¼ | 2¼ | ¼ to $\frac{9}{32}$ | ¼ to $\frac{9}{32}$ | 3.83 | 50 |
| T-33 | 2 | 2 | $\frac{5}{16}$ to $\frac{11}{32}$ | $\frac{5}{16}$ to $\frac{11}{32}$ | 4.1 | 50 |
| T-34 | 2 | 2 | ¼ to $\frac{9}{32}$ | ¼ to $\frac{9}{32}$ | 3.38 | 50 |
| T-39 | 1¾ | 1¾ | ¼ to $\frac{9}{32}$ | ¼ to $\frac{9}{32}$ | 2.93 | 40 |
| T-40 | 1¾ | 1¾ | $\frac{3}{16}$ to $\frac{7}{32}$ | $\frac{3}{16}$ to $\frac{7}{32}$ | 2.28 | 40 |

# Tees With Equal Legs

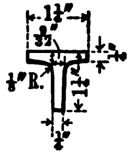
**Continued**



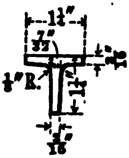
**T-45**
**2.47 lbs.**



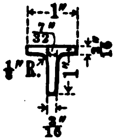
**T-46**
**1.94 lbs.**



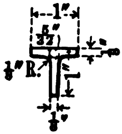
**T-51**
**2.02 lbs.**



**T-52**
**1.59 lbs.**



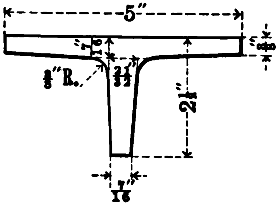
**T-57**
**1.25 lbs.**



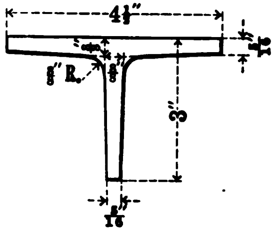
**T-58**
**0.89 lbs.**

| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| T-45 | 1½ | 1½ | ¼ to 9/32 | ¼ to 9/32 | 2.47 | 40 |
| T-46 | 1½ | 1½ | 3/16 to 7/32 | 3/16 to 7/32 | 1.94 | 40 |
| T-51 | 1¼ | 1¼ | ¼ to 9/32 | ¼ to 9/32 | 2.02 | 45 |
| T-52 | 1¼ | 1¼ | 3/16 to 7/32 | 3/16 to 7/32 | 1.59 | 45 |
| T-57 | 1 | 1 | 3/16 to 7/32 | 3/16 to 7/32 | 1.25 | 45 |
| T-58 | 1 | 1 | ⅛ to 5/32 | ⅛ to 5/32 | .89 | 45 |

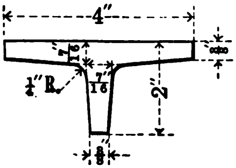
# Tees With Unequal Legs



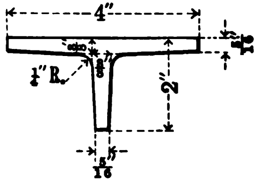
***T-69**
10.9 lbs.



***T-74**
8.4 lbs.



**T-79**
7.8 lbs.



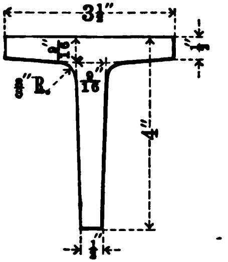
**T-80**
6.7 lbs.

| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| *T-69 | 5 | 2½ | $\frac{3}{8}$ to $\frac{7}{16}$ | $\frac{7}{16}$ to $\frac{21}{32}$ | 10.9 | 40 |
| *T-74 | 4½ | 3 | $\frac{5}{16}$ to $\frac{3}{8}$ | $\frac{5}{16}$ to $\frac{3}{8}$ | 8.4 | 40 |
| T-79 | 4 | 2 | $\frac{3}{8}$ to $\frac{7}{16}$ | $\frac{3}{8}$ to $\frac{7}{16}$ | 7.8 | 40 |
| *T-80* | 4 | 2 | $\frac{5}{16}$ to $\frac{3}{8}$ | $\frac{5}{16}$ to $\frac{3}{8}$ | 6.7 | 40 |

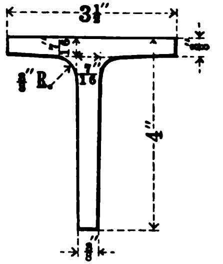
**Made only by special arrangement.*

# Tees With Unequal Legs

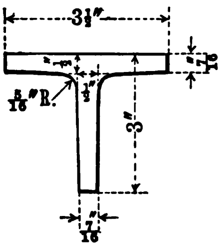
**Continued**



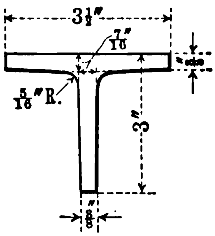

**T-85**
12.6 lbs.




**T-86**
9.8 lbs.




**T-91**
9.7 lbs.

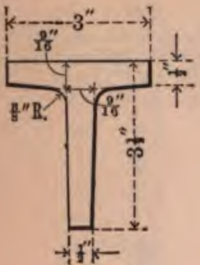



**T-92**
8.5 lbs.

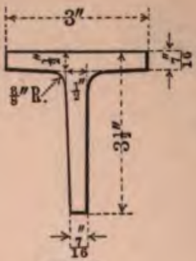
| ction idex | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| -85 | 3½ | 4 | ½ to 9/16 | ½ to 9/16 | 12.6 | 40 |
| -86 | 3½ | 4 | ⅜ to 7/16 | ⅜ to 7/16 | 9.8 | 40 |
| -91 | 3½ | 3 | 7/16 to ½ | 7/16 to ½ | 9.7 | 40 |
| -92 | 3½ | 3 | ⅜ to 7/16 | ⅜ to 7/16 | 8.5 | 40 |

# Tees With Unequal Legs

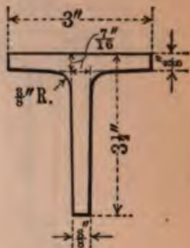
**Continued**



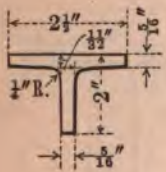
**T-96**
10.8 lbs.



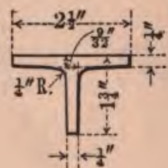
**T-97**
9.7 lbs.



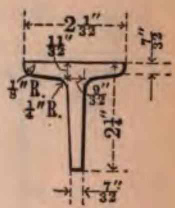
**T-98**
8.5 lbs.



**T-103**
4.7 lbs.



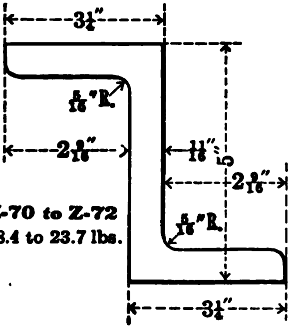
**T-108**
3.60 lbs.



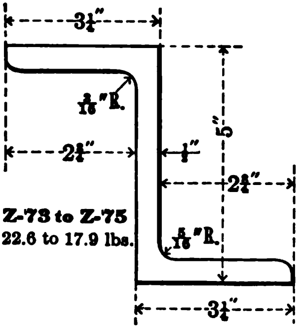
**T-112**
3.65 lbs.

| Section Index | Size, Inches | | Thickness of Metal, Inches | | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Stem | Flange | Stem | | |
| T- 96 | 3 | 3½ | ½ to $\frac{9}{16}$ | ½ to $\frac{9}{16}$ | 10.8 | 40 |
| T- 97 | 3 | 3½ | $\frac{7}{16}$ to ½ | $\frac{7}{16}$ to ½ | 9.7 | 40 |
| T- 98 | 3 | 3½ | ⅜ to $\frac{7}{16}$ | ⅜ to $\frac{7}{16}$ | 8.5 | 40 |
| T-103 | 2½ | 2 | $\frac{5}{16}$ to $\frac{11}{32}$ | $\frac{5}{16}$ to $\frac{11}{32}$ | 4.7 | 50 |
| T-108 | 2½ | 1¾ | ¼ to $\frac{9}{32}$ | ¼ to $\frac{9}{32}$ | 3.60 | 50 |
| *T-112* | $2\frac{1}{32}$ | 2¼ | $\frac{7}{32}$ to $\frac{11}{32}$ | $\frac{7}{32}$ to $\frac{9}{32}$ | 3.65 | 50 |

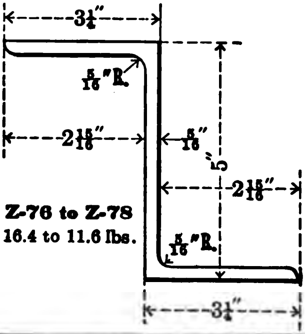
# Zees



**Z-70 to Z-72**
**28.4 to 23.7 lbs.**



**Z-73 to Z-75**
**22.6 to 17.9 lbs.**

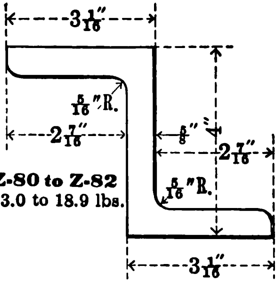


**Z-76 to Z-78**
**16.4 to 11.6 lbs.**

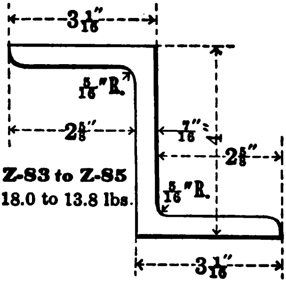
| Section Index | Size, Inches | | | Thickness of Metal, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Web | Flange | | | |
| Z-70 | $3\frac{3}{8}$ | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{13}{16}$ | 28.4 | 37 |
| Z-71 | $3\frac{5}{16}$ | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{3}{4}$ | 26.0 | 40 |
| Z-72 | $3\frac{1}{4}$ | 5 | $3\frac{1}{4}$ | $\frac{11}{16}$ | 23.7 | 44 |
| Z-73 | $3\frac{3}{8}$ | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{5}{8}$ | 22.6 | 46 |
| Z-74 | $3\frac{5}{16}$ | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{9}{16}$ | 20.2 | 52 |
| Z-75 | $3\frac{1}{4}$ | 5 | $3\frac{1}{4}$ | $\frac{1}{2}$ | 17.9 | 60 |
| Z-76 | $3\frac{3}{8}$ | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{7}{16}$ | 16.4 | 61 |
| Z-77 | $3\frac{5}{16}$ | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{3}{8}$ | 14.0 | 65 |
| Z-78 | $3\frac{1}{4}$ | 5 | $3\frac{1}{4}$ | $\frac{5}{16}$ | 11.6 | 65 |

# Zees

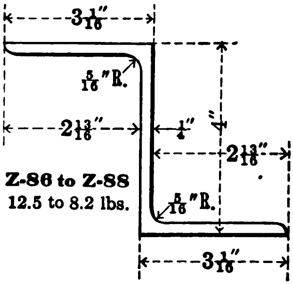
**Continued**




**Z-80 to Z-82**
23.0 to 18.9 lbs.




**Z-83 to Z-85**
18.0 to 13.8 lbs.

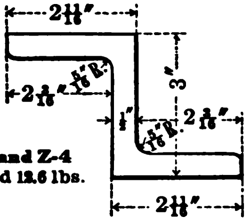



**Z-86 to Z-88**
12.5 to 8.2 lbs.

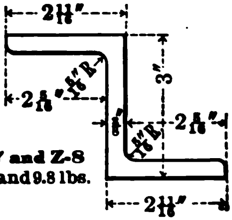
| Section Index | Size, Inches | | | Thickness of Metal, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Web | Flange | | | |
| Z-80 | $3\frac{3}{16}$ | $4\frac{1}{8}$ | $3\frac{3}{16}$ | $\frac{3}{4}$ | 23.0 | 38 |
| Z-81 | $3\frac{1}{8}$ | $4\frac{1}{16}$ | $3\frac{1}{8}$ | $\frac{11}{16}$ | 20.9 | 42 |
| Z-82 | $3\frac{1}{16}$ | 4 | $3\frac{1}{16}$ | $\frac{5}{8}$ | 18.9 | 46 |
| Z-83 | $3\frac{3}{16}$ | $4\frac{1}{8}$ | $3\frac{3}{16}$ | $\frac{9}{16}$ | 18.0 | 48 |
| Z-84 | $3\frac{1}{8}$ | $4\frac{1}{16}$ | $3\frac{1}{8}$ | $\frac{1}{2}$ | 15.9 | 55 |
| Z-85 | $3\frac{1}{16}$ | 4 | $3\frac{1}{16}$ | $\frac{7}{16}$ | 13.8 | 62 |
| Z-86 | $3\frac{3}{16}$ | $4\frac{1}{8}$ | $3\frac{3}{16}$ | $\frac{3}{8}$ | 12.5 | 65 |
| Z-87 | $3\frac{1}{8}$ | $4\frac{1}{16}$ | $3\frac{1}{8}$ | $\frac{5}{16}$ | 10.3 | 65 |
| Z-88 | $3\frac{1}{16}$ | 4 | $3\frac{1}{16}$ | $\frac{1}{4}$ | 8.2 | 65 |

# Zees

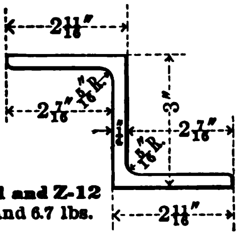
**Continued**



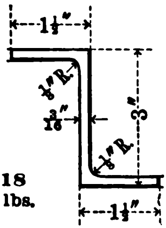
**Z-3 and Z-4**
**14.3 and 12.6 lbs.**



**Z-7 and Z-8**
**11.5 and 9.8 lbs.**



**Z-11 and Z-12**
**8.5 and 6.7 lbs.**



**Z-18**
**3.59 lbs.**

| Section Index | Size, Inches | | | Thickness of Metal, Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|---|---|---|
| | Flange | Web | Flange | | | |
| Z- 3 | 2¾ | 3 1/16 | 2¾ | 9/16 | 14.3 | 56 |
| Z- 4 | 2 11/16 | 3 | 2 11/16 | ½ | 12.6 | 64 |
| Z- 7 | 2¾ | 3 1/16 | 2¾ | 7/16 | 11.5 | 65 |
| Z- 8 | 2 11/16 | 3 | 2 11/16 | ⅜ | 9.8 | 65 |
| Z-11 | 2¾ | 3 1/16 | 2¾ | 5/16 | 8.5 | 65 |
| Z-12 | 2 11/16 | 3 | 2 11/16 | ¼ | 6.7 | 65 |
| Z-18 | 1½ | 3 | 1½ | 3/16 | 3.59 | 65 |

# Areas of Angles
## Square Inches

| Size, Inches | $\frac{1}{8}$ | $\frac{3}{16}$ | $\frac{1}{4}$ | $\frac{5}{16}$ | $\frac{3}{8}$ | $\frac{7}{16}$ | $\frac{1}{2}$ | $\frac{9}{16}$ | $\frac{5}{8}$ | $\frac{11}{16}$ | $\frac{3}{4}$ | $\frac{13}{16}$ | $\frac{7}{8}$ | $\frac{15}{16}$ | 1 | $1\frac{1}{16}$ | $1\frac{1}{8}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 x8 | | | | | | | 7.75 | 8.68 | 9.61 | 10.53 | 11.44 | 12.34 | 13.23 | 14.12 | 15.00 | 15.87 | 16.73 |
| 8 x6 | | | | | | 5.94 | 6.75 | 7.56 | 8.36 | 9.15 | 9.94 | 10.72 | 11.48 | 12.25 | 13.00 | 13.77 | 14.50 |
| 7 x3½ | | | | | 3.81 | 4.40 | 5.00 | 5.59 | 6.17 | 6.75 | 7.31 | 7.87 | 8.42 | | | | |
| 6 x6 | | | | | 4.36 | 5.06 | 5.75 | 6.43 | 7.11 | 7.78 | 8.44 | 9.09 | 9.73 | 10.37 | 11.00 | | |
| 6 x4 | | | | | 3.61 | 4.18 | 4.75 | 5.31 | 5.86 | 6.40 | 6.94 | 7.47 | | | | | |
| 6 x3½ | | | | | 3.42 | 3.97 | 4.50 | 5.03 | 5.55 | 6.06 | 6.56 | | | | | | |
| 5 x5 | | | | | 3.61 | 4.18 | 4.75 | 5.31 | 5.86 | 6.40 | 6.94 | 7.47 | 7.99 | 8.50 | | | |
| 5 x4 | | | | | 3.23 | 3.75 | 4.25 | 4.75 | 5.23 | 5.71 | 6.19 | 6.65 | | | | | |
| 5 x3½ | | | | 2.56 | 3.05 | 3.53 | 4.00 | 4.47 | 4.92 | 5.37 | 5.81 | | | | | | |
| 5 x3 | | | | 2.40 | 2.86 | 3.31 | 3.75 | 4.18 | 4.61 | 5.03 | | | | | | | |
| 4½x3 | | | | 2.25 | 2.67 | 3.09 | 3.50 | 3.90 | 4.30 | 4.68 | | | | | | | |
| 4 x4 | | | 1.94 | 2.40 | 2.86 | 3.31 | 3.75 | 4.18 | 4.61 | 5.03 | 5.44 | 5.84 | | | | | |
| 4 x3½ | | | | 2.25 | 2.67 | 3.09 | 3.50 | 3.90 | 4.30 | 4.68 | 5.06 | 5.43 | | | | | |
| 4 x3 | | $\frac{5}{32}$ 1.07 | 1.69 | 2.09 | 2.48 | 2.87 | 3.25 | 3.62 | 3.98 | 4.34 | | | | | | | |
| 3½x3½ | | | 1.69 | 2.09 | 2.48 | 2.87 | 3.25 | 3.62 | 3.98 | 4.34 | 4.69 | | | | | | |
| 3½x3 | | | 1.56 | 1.93 | 2.30 | 2.65 | 3.00 | 3.34 | 3.67 | 4.00 | | | | | | | |
| 3½x2½ | | | 1.44 | 1.78 | 2.11 | 2.43 | 2.75 | 3.06 | | | | | | | | | |
| 3 x3 | 0.73 | 1.09 | 1.44 | 1.78 | 2.11 | 2.43 | 2.75 | 3.06 | 3.36 | | | | | | | | |
| 3 x2½ | | | 1.31 | 1.62 | 1.92 | 2.21 | 2.50 | 2.78 | | | | | | | | | |
| 3 x2 | | 0.91 | 1.19 | 1.47 | 1.73 | 2.00 | 2.25 | | | | | | | | | | |
| 2½x2½ | 0.61 | 0.90 | 1.19 | 1.47 | 1.73 | 2.00 | 2.25 | | | | | | | | | | |
| 2½x2 | | 0.81 | 1.06 | 1.31 | 1.55 | 1.78 | 2.00 | | | | | | | | | | |
| 2 x2 | 0.48 | 0.71 | 0.94 | 1.15 | 1.36 | 1.56 | 1.75 | | | | | | | | | | |
| 1½x1½ | 0.36 | 0.53 | 0.69 | 0.84 | 0.99 | | | | | | | | | | | | |
| 1 x1 | 0.23 | 0.34 | 0.44 | | | | | | | | | | | | | | |

## Rounds

$\frac{5}{16}''$ to $1''$ advancing by 64ths.
$1\frac{1}{32}''$ to $2''$ advancing by 32nds.
$2\frac{1}{16}''$ to $7\frac{1}{2}''$ advancing by 16ths.

We have grooves for rolling a large variety of bolt and rivet sizes to decimal diameters.

Sizes $\frac{3}{4}''$ and under can be furnished in coils.

## Squares

$\frac{3}{16}''$ to $2''$ advancing by 64ths.
$2\frac{1}{16}''$ to $5''$ advancing by 16ths.

All intermediate sizes can be rolled by special arrangement.

# Maximum Length of Rounds

| Diameter, Inches | Length, Feet |
|---|---|
| 1/4 to 7/8 | 40 |
| 15/16 to 2 1/16 | 60 |
| 2 1/8 to 4 1/2 | 48 |
| 4 9/16 to 5 1/2 | 46 |
| 5 9/16 | 44 |
| 5 5/8 | 43 |
| 5 11/16 | 42 |
| 5 3/4 | 41 |
| 5 13/16 | 40 |
| 5 7/8 to 5 15/16 | 39 |
| 6 | 38 |
| 6 1/8 | 37 |
| 6 3/16 | 36 |
| 6 1/4 | 35 |
| 6 5/16 and 6 3/8 | 34 |
| 6 7/16 | 33 |
| 6 1/2 | 32 |
| 6 9/16 and 6 5/8 | 31 |
| 6 11/16 and 6 3/4 | 30 |
| 6 13/16 and 6 7/8 | 29 |
| 6 15/16 and 7 | 28 |
| 7 1/16 and 7 1/8 | 27 |
| 7 3/16 to 7 5/16 | 26 |
| 7 1/16 to 7 3/8 | 26 |
| 7 7/16 to 7 1/2 | 25 |

**For rounds in coils, see our Shape Book.**

# Maximum Length of Squares

| Size, Inches | Length, Feet |
|---|---|
| 1/4 to 11/16 | 40 |
| 3/4 to 2 | 60 |
| 2 1/16 to 4 15/16 | 48 |
| 5 | 45 |

nger lengths can be rolled only by special arrangement.

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

**One Cubic Foot of Steel Weighing 489.6 lbs.**

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 1/16 | .013 | .010 | .0039 | .0031 | .1964 |
| 5/64 | .021 | .016 | .0061 | .0048 | .2454 |
| 3/32 | .030 | .023 | .0088 | .0069 | .2945 |
| 7/64 | .041 | .032 | .0120 | .0094 | .3436 |
| 1/8 | .053 | .042 | .0156 | .0123 | .3927 |
| 9/64 | .067 | .053 | .0198 | .0155 | .4418 |
| 5/32 | .083 | .065 | .0244 | .0192 | .4908 |
| 11/64 | .100 | .079 | .0295 | .0232 | .5400 |
| 3/16 | .120 | .094 | .0352 | .0276 | .5891 |
| 13/64 | .140 | .110 | .0413 | .0324 | .6381 |
| 7/32 | .163 | .128 | .0479 | .0376 | .6872 |
| 15/64 | .187 | .147 | .0549 | .0431 | .7363 |
| 1/4 | .212 | .167 | .0625 | .0491 | .7854 |
| 17/64 | .240 | .188 | .0706 | .0554 | .8345 |
| 9/32 | .269 | .211 | .0791 | .0621 | .8836 |
| 19/64 | .300 | .235 | .0881 | .0692 | .9327 |
| 5/16 | .332 | .261 | .0977 | .0767 | .9818 |
| 21/64 | .366 | .288 | .1077 | .0846 | 1.0308 |
| 11/32 | .402 | .316 | .1182 | .0928 | 1.0799 |
| 23/64 | .439 | .345 | .1292 | .1014 | 1.1290 |
| 3/8 | .478 | .376 | .1406 | .1104 | 1.1781 |
| 25/64 | .519 | .407 | .1526 | .1198 | 1.2272 |
| 13/32 | .561 | .441 | .1650 | .1296 | 1.2763 |
| 27/64 | .605 | .475 | .1780 | .1398 | 1.3254 |
| 7/16 | .651 | .511 | .1914 | .1503 | 1.3745 |
| 29/64 | .698 | .548 | .2053 | .1613 | 1.4235 |
| 15/32 | .747 | .587 | .2197 | .1726 | 1.4726 |
| 31/64 | .798 | .627 | .2346 | .1843 | 1.5217 |
| 1/2 | .850 | .668 | .2500 | .1963 | 1.5708 |
| 33/64 | .904 | .710 | .2659 | .2088 | 1.6199 |
| 17/32 | .960 | .754 | .2822 | .2217 | 1.6690 |
| 35/64 | 1.017 | .799 | .2991 | .2349 | 1.7181 |
| 9/16 | 1.076 | .845 | .3164 | .2485 | 1.7671 |

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

Continued

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 37/64 | 1.136 | .893 | .3342 | .2625 | 1.8162 |
| 19/32 | 1.199 | .941 | .3525 | .2769 | 1.8653 |
| 39/64 | 1.263 | .992 | .3713 | .2916 | 1.9144 |
| 5/8 | 1.328 | 1.043 | .3906 | .3068 | 1.9635 |
| 41/64 | 1.395 | 1.096 | .4104 | .3223 | 2.0126 |
| 21/32 | 1.464 | 1.150 | .4307 | .3382 | 2.0617 |
| 43/64 | 1.535 | 1.205 | .4514 | .3545 | 2.1108 |
| 11/16 | 1.607 | 1.262 | .4727 | .3712 | 2.1598 |
| 45/64 | 1.681 | 1.320 | .4944 | .3883 | 2.2089 |
| 23/32 | 1.756 | 1.379 | .5166 | .4057 | 2.2580 |
| 47/64 | 1.834 | 1.440 | .5393 | .4236 | 2.3071 |
| 3/4 | 1.913 | 1.502 | .5625 | .4418 | 2.3562 |
| 49/64 | 1.993 | 1.565 | .5862 | .4604 | 2.4053 |
| 25/32 | 2.075 | 1.630 | .6103 | .4794 | 2.4544 |
| 51/64 | 2.159 | 1.696 | .6350 | .4987 | 2.5035 |
| 13/16 | 2.245 | 1.763 | .6602 | .5185 | 2.5525 |
| 53/64 | 2.332 | 1.831 | .6858 | .5386 | 2.6016 |
| 27/32 | 2.420 | 1.901 | .7119 | .5591 | 2.6507 |
| 55/64 | 2.511 | 1.972 | .7385 | .5800 | 2.6998 |
| 7/8 | 2.603 | 2.044 | .7656 | .6013 | 2.7489 |
| 57/64 | 2.697 | 2.118 | .7932 | .6230 | 2.7980 |
| 29/32 | 2.792 | 2.193 | .8213 | .6450 | 2.8471 |
| 59/64 | 2.889 | 2.270 | .8498 | .6675 | 2.8962 |
| 15/16 | 2.988 | 2.347 | .8789 | .6903 | 2.9453 |
| 61/64 | 3.089 | 2.426 | .9084 | .7135 | 2.9943 |
| 31/32 | 3.191 | 2.506 | .9385 | .7371 | 3.0434 |
| 63/64 | 3.294 | 2.587 | .9689 | .7610 | 3.0925 |
| 1 | 3.400 | 2.670 | 1.0000 | .7854 | 3.1416 |
| 1/32 | 3.616 | 2.840 | 1.0635 | .8353 | 3.2398 |
| 1/16 | 3.838 | 3.014 | 1.1289 | .8866 | 3.3379 |
| 3/32 | 4.067 | 3.194 | 1.1963 | .9396 | 3.4361 |
| 1/8 | 4.303 | 3.379 | 1.2656 | .9940 | 3.5343 |

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

Continued

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 1 5/32 | 4.545 | 3.570 | 1.3369 | 1.0500 | 3.6325 |
| 3/16 | 4.795 | 3.766 | 1.4102 | 1.1075 | 3.7306 |
| 7/32 | 5.050 | 3.966 | 1.4853 | 1.1666 | 3.8288 |
| 1/4 | 5.312 | 4.173 | 1.5625 | 1.2272 | 3.9270 |
| 9/32 | 5.581 | 4.384 | 1.6416 | 1.2893 | 4.0252 |
| 5/16 | 5.857 | 4.600 | 1.7227 | 1.3530 | 4.1233 |
| 11/32 | 6.139 | 4.822 | 1.8056 | 1.4182 | 4.2215 |
| 3/8 | 6.428 | 5.049 | 1.8906 | 1.4849 | 4.3197 |
| 13/32 | 6.724 | 5.281 | 1.9775 | 1.5532 | 4.4179 |
| 7/16 | 7.026 | 5.518 | 2.0664 | 1.6230 | 4.5160 |
| 15/32 | 7.334 | 5.761 | 2.1572 | 1.6943 | 4.6142 |
| 1/2 | 7.650 | 6.008 | 2.2500 | 1.7671 | 4.7124 |
| 17/32 | 7.972 | 6.261 | 2.3447 | 1.8415 | 4.8106 |
| 9/16 | 8.301 | 6.520 | 2.4414 | 1.9175 | 4.9087 |
| 19/32 | 8.636 | 6.783 | 2.5400 | 1.9949 | 5.0069 |
| 5/8 | 8.978 | 7.051 | 2.6406 | 2.0739 | 5.1051 |
| 21/32 | 9.327 | 7.325 | 2.7431 | 2.1545 | 5.2033 |
| 11/16 | 9.682 | 7.604 | 2.8477 | 2.2365 | 5.3014 |
| 23/32 | 10.05 | 7.889 | 2.9541 | 2.3202 | 5.3996 |
| 3/4 | 10.41 | 8.178 | 3.0625 | 2.4053 | 5.4978 |
| 25/32 | 10.79 | 8.473 | 3.1728 | 2.4920 | 5.5960 |
| 13/16 | 11.17 | 8.773 | 3.2852 | 2.5802 | 5.6941 |
| 27/32 | 11.56 | 9.078 | 3.3994 | 2.6699 | 5.7923 |
| 7/8 | 11.95 | 9.388 | 3.5156 | 2.7612 | 5.8905 |
| 29/32 | 12.36 | 9.704 | 3.6337 | 2.8540 | 5.9887 |
| 15/16 | 12.76 | 10.02 | 3.7539 | 2.9483 | 6.0868 |
| 31/32 | 13.18 | 10.35 | 3.8760 | 3.0442 | 6.1850 |
| 2 | 13.60 | 10.68 | 4.0000 | 3.1416 | 6.2832 |
| 1/16 | 14.46 | 11.36 | 4.2539 | 3.3410 | 6.4795 |
| 1/8 | 15.35 | 12.06 | 4.5156 | 3.5466 | 6.6759 |
| 3/16 | 16.27 | 12.78 | 4.7852 | 3.7583 | 6.8722 |
| 1/4 | 17.22 | 13.52 | 5.0625 | 3.9761 | 7.0686 |

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

Continued

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| $2\frac{5}{16}$ | 18.19 | 14.28 | 5.3477 | 4.2000 | 7.2649 |
| $\frac{3}{8}$ | 19.18 | 15.07 | 5.6406 | 4.4301 | 7.4613 |
| $\frac{7}{16}$ | 20.20 | 15.86 | 5.9414 | 4.6664 | 7.6576 |
| $\frac{1}{2}$ | 21.25 | 16.69 | 6.2500 | 4.9087 | 7.8540 |
| $\frac{9}{16}$ | 22.33 | 17.53 | 6.5664 | 5.1572 | 8.0503 |
| $\frac{5}{8}$ | 23.43 | 18.40 | 6.8906 | 5.4119 | 8.2467 |
| $\frac{11}{16}$ | 24.56 | 19.29 | 7.2227 | 5.6727 | 8.4430 |
| $\frac{3}{4}$ | 25.71 | 20.20 | 7.5625 | 5.9396 | 8.6394 |
| $\frac{13}{16}$ | 26.90 | 21.12 | 7.9102 | 6.2126 | 8.8357 |
| $\frac{7}{8}$ | 28.10 | 22.07 | 8.2656 | 6.4918 | 9.0321 |
| $\frac{15}{16}$ | 29.34 | 23.04 | 8.6289 | 6.7771 | 9.2284 |
| 3 | 30.60 | 24.03 | 9.0000 | 7.0686 | 9.4248 |
| $\frac{1}{16}$ | 31.89 | 25.04 | 9.3789 | 7.3662 | 9.6211 |
| $\frac{1}{8}$ | 33.20 | 26.08 | 9.7656 | 7.6699 | 9.8175 |
| $\frac{3}{16}$ | 34.55 | 27.13 | 10.160 | 7.9798 | 10.014 |
| $\frac{1}{4}$ | 35.92 | 28.20 | 10.563 | 8.2958 | 10.210 |
| $\frac{5}{16}$ | 37.31 | 29.30 | 10.973 | 8.6179 | 10.407 |
| $\frac{3}{8}$ | 38.73 | 30.42 | 11.391 | 8.9462 | 10.603 |
| $\frac{7}{16}$ | 40.18 | 31.56 | 11.816 | 9.2806 | 10.799 |
| $\frac{1}{2}$ | 41.65 | 32.71 | 12.250 | 9.6211 | 10.996 |
| $\frac{9}{16}$ | 43.14 | 33.90 | 12.691 | 9.9678 | 11.192 |
| $\frac{5}{8}$ | 44.68 | 35.09 | 13.141 | 10.321 | 11.388 |
| $\frac{11}{16}$ | 46.24 | 36.31 | 13.598 | 10.680 | 11.585 |
| $\frac{3}{4}$ | 47.82 | 37.56 | 14.063 | 11.045 | 11.781 |
| $\frac{13}{16}$ | 49.42 | 38.81 | 14.535 | 11.416 | 11.977 |
| $\frac{7}{8}$ | 51.05 | 40.10 | 15.016 | 11.793 | 12.174 |
| $\frac{15}{16}$ | 52.71 | 41.40 | 15.504 | 12.177 | 12.370 |
| 4 | 54.40 | 42.73 | 16.000 | 12.566 | 12.566 |
| $\frac{1}{16}$ | 56.11 | 44.07 | 16.504 | 12.962 | 12.763 |
| $\frac{1}{8}$ | 57.85 | 45.44 | 17.016 | 13.364 | 12.959 |
| $\frac{3}{16}$ | 59.62 | 46.83 | 17.535 | 13.772 | 13.155 |
| $\frac{1}{4}$ | 61.41 | 48.24 | 18.063 | 14.186 | 13.352 |

## Weights and Areas

### Square and Round Bars and Circumferences of Round Bars

Continued

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 4 5/16 | 63.23 | 49.66 | 18.598 | 14.607 | 13.548 |
| 3/8 | 65.08 | 51.11 | 19.141 | 15.033 | 13.744 |
| 7/16 | 66.95 | 52.58 | 19.691 | 15.466 | 13.941 |
| 1/2 | 68.85 | 54.07 | 20.250 | 15.904 | 14.137 |
| 9/16 | 70.78 | 55.59 | 20.816 | 16.349 | 14.334 |
| 5/8 | 72.73 | 57.12 | 21.391 | 16.800 | 14.530 |
| 11/16 | 74.70 | 58.67 | 21.973 | 17.257 | 14.726 |
| 3/4 | 76.71 | 60.25 | 22.563 | 17.721 | 14.923 |
| 13/16 | 78.74 | 61.84 | 23.160 | 18.190 | 15.119 |
| 7/8 | 80.81 | 63.46 | 23.766 | 18.665 | 15.315 |
| 15/16 | 82.89 | 65.10 | 24.379 | 19.147 | 15.512 |
| 5 | 85.00 | 66.76 | 25.000 | 19.635 | 15.708 |
| 1/16 | 87.14 | 68.44 | 25.629 | 20.129 | 15.904 |
| 1/8 | 89.30 | 70.14 | 26.266 | 20.629 | 16.101 |
| 3/16 | 91.49 | 71.86 | 26.910 | 21.135 | 16.297 |
| 1/4 | 93.72 | 73.60 | 27.563 | 21.648 | 16.493 |
| 5/16 | 95.96 | 75.37 | 28.223 | 22.166 | 16.690 |
| 3/8 | 98.23 | 77.15 | 28.891 | 22.691 | 16.886 |
| 7/16 | 100.5 | 78.93 | 29.566 | 23.221 | 17.082 |
| 1/2 | 102.8 | 80.77 | 30.250 | 23.758 | 17.279 |
| 9/16 | 105.2 | 82.62 | 30.941 | 24.301 | 17.475 |
| 5/8 | 107.6 | 84.49 | 31.641 | 24.850 | 17.671 |
| 11/16 | 110.0 | 86.38 | 32.348 | 25.406 | 17.868 |
| 3/4 | 112.4 | 88.29 | 33.063 | 25.967 | 18.064 |
| 13/16 | 114.9 | 90.22 | 33.785 | 26.535 | 18.261 |
| 7/8 | 117.4 | 92.17 | 34.516 | 27.109 | 18.457 |
| 15/16 | 119.9 | 94.14 | 35.254 | 27.688 | 18.653 |
| 6 | 122.4 | 96.14 | 36.000 | 28.274 | 18.850 |
| 1/16 | 125.0 | 98.14 | 36.754 | 28.866 | 19.046 |
| 1/8 | 127.6 | 100.2 | 37.516 | 29.465 | 19.242 |
| 3/16 | 130.2 | 102.2 | 38.285 | 30.069 | 19.439 |
| 1/4 | 132.8 | 104.3 | 39.063 | 30.680 | 19.635 |

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

**Continued**

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 6 5/16 | 135.5 | 106.4 | 39.848 | 31.296 | 19.831 |
| 3/8 | 138.2 | 108.5 | 40.641 | 31.919 | 20.028 |
| 7/16 | 140.9 | 110.7 | 41.441 | 32.548 | 20.224 |
| 1/2 | 143.6 | 112.8 | 42.250 | 33.183 | 20.420 |
| 9/16 | 146.5 | 114.9 | 43.066 | 33.824 | 20.617 |
| 5/8 | 149.2 | 117.2 | 43.891 | 34.472 | 20.813 |
| 11/16 | 152.1 | 119.4 | 44.723 | 35.125 | 21.009 |
| 3/4 | 154.9 | 121.7 | 45.563 | 35.785 | 21.206 |
| 13/16 | 157.8 | 123.9 | 46.410 | 36.450 | 21.402 |
| 7/8 | 160.8 | 126.2 | 47.266 | 37.122 | 21.598 |
| 15/16 | 163.6 | 128.5 | 48.129 | 37.800 | 21.795 |
| 7 | 166.6 | 130.9 | 49.000 | 38.485 | 21.991 |
| 1/16 | 169.6 | 133.2 | 49.879 | 39.175 | 22.187 |
| 1/8 | 172.6 | 135.6 | 50.766 | 39.871 | 22.384 |
| 3/16 | 175.6 | 137.9 | 51.660 | 40.574 | 22.580 |
| 1/4 | 178.7 | 140.4 | 52.563 | 41.282 | 22.777 |
| 5/16 | 181.8 | 142.8 | 53.473 | 41.997 | 22.973 |
| 3/8 | 184.9 | 145.3 | 54.391 | 42.718 | 23.169 |
| 7/16 | 188.1 | 147.7 | 55.316 | 43.445 | 23.366 |
| 1/2 | 191.3 | 150.2 | 56.250 | 44.179 | 23.562 |
| 9/16 | 194.4 | 152.7 | 57.191 | 44.918 | 23.758 |
| 5/8 | 197.7 | 155.2 | 58.141 | 45.664 | 23.955 |
| 11/16 | 200.9 | 157.8 | 59.098 | 46.415 | 24.151 |
| 3/4 | 204.2 | 160.3 | 60.063 | 47.173 | 24.347 |
| 13/16 | 207.6 | 163.0 | 61.035 | 47.937 | 24.544 |
| 7/8 | 210.8 | 165.6 | 62.016 | 48.707 | 24.740 |
| 15/16 | 214.2 | 168.2 | 63.004 | 49.483 | 24.936 |
| 8 | 217.6 | 171.0 | 64.000 | 50.265 | 25.133 |

# Areas of Bars and Plates

## Square Inches

| Width, Inches | Thickness, Inches 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | .031 | .063 | .094 | .125 | .156 | .188 | .219 | .25 | .28 | .31 | .34 | .38 | .41 | .44 | .47 | .50 |
| 1 | .063 | .125 | .188 | .250 | .313 | .375 | .438 | .50 | .56 | .63 | .69 | .75 | .81 | .88 | .94 | 1.00 |
| 2 | .125 | .250 | .375 | .500 | .625 | .750 | .875 | 1.00 | 1.13 | 1.25 | 1.38 | 1.50 | 1.63 | 1.75 | 1.88 | 2.00 |
| 3 | .188 | .375 | .563 | .750 | .938 | 1.125 | 1.313 | 1.50 | 1.69 | 1.88 | 2.06 | 2.25 | 2.44 | 2.63 | 2.81 | 3.00 |
| 4 | .250 | .500 | .750 | 1.000 | 1.250 | 1.500 | 1.750 | 2.00 | 2.25 | 2.50 | 2.75 | 3.00 | 3.25 | 3.50 | 3.75 | 4.00 |
| 5 | .313 | .625 | .938 | 1.250 | 1.563 | 1.875 | 2.188 | 2.50 | 2.81 | 3.13 | 3.44 | 3.75 | 4.06 | 4.38 | 4.69 | 5.00 |
| 6 | .375 | .750 | 1.125 | 1.500 | 1.875 | 2.250 | 2.625 | 3.00 | 3.38 | 3.75 | 4.13 | 4.50 | 4.88 | 5.25 | 5.63 | 6.00 |
| 7 | .438 | .875 | 1.313 | 1.750 | 2.188 | 2.625 | 3.063 | 3.50 | 3.94 | 4.38 | 4.81 | 5.25 | 5.69 | 6.13 | 6.56 | 7.00 |
| 8 | .500 | 1.000 | 1.500 | 2.000 | 2.500 | 3.000 | 3.500 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 |
| 9 | .563 | 1.125 | 1.688 | 2.250 | 2.813 | 3.375 | 3.938 | 4.50 | 5.06 | 5.63 | 6.19 | 6.75 | 7.31 | 7.88 | 8.44 | 9.00 |
| 10 | .625 | 1.250 | 1.875 | 2.50 | 3.13 | 3.75 | 4.38 | 5.00 | 5.63 | 6.25 | 6.88 | 7.50 | 8.13 | 8.75 | 9.38 | 10.00 |
| 11 | .688 | 1.375 | 2.063 | 2.75 | 3.44 | 4.13 | 4.81 | 5.50 | 6.19 | 6.88 | 7.56 | 8.25 | 8.94 | 9.63 | 10.31 | 11.00 |
| 12 | .750 | 1.500 | 2.250 | 3.00 | 3.75 | 4.50 | 5.25 | 6.00 | 6.75 | 7.50 | 8.25 | 9.00 | 9.75 | 10.50 | 11.25 | 12.00 |
| 13 | .813 | 1.625 | 2.438 | 3.25 | 4.06 | 4.88 | 5.69 | 6.50 | 7.31 | 8.13 | 8.94 | 9.75 | 10.56 | 11.38 | 12.19 | 13.00 |
| 14 | .875 | 1.750 | 2.625 | 3.50 | 4.38 | 5.25 | 6.13 | 7.00 | 7.88 | 8.75 | 9.63 | 10.50 | 11.38 | 12.25 | 13.13 | 14.00 |
| 15 | .938 | 1.875 | 2.813 | 3.75 | 4.69 | 5.63 | 6.56 | 7.50 | 8.44 | 9.38 | 10.31 | 11.25 | 12.19 | 13.13 | 14.06 | 15.00 |
| 16 | 1.000 | 2.000 | 3.000 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 |
| 17 | 1.063 | 2.125 | 3.188 | 4.25 | 5.31 | 6.38 | 7.44 | 8.50 | 9.56 | 10.63 | 11.69 | 12.75 | 13.81 | 14.88 | 15.94 | 17.00 |
| 18 | 1.125 | 2.250 | 3.375 | 4.50 | 5.63 | 6.75 | 7.88 | 9.00 | 10.13 | 11.25 | 12.38 | 13.50 | 14.63 | 15.75 | 16.88 | 18.00 |
| 19 | 1.188 | 2.375 | 3.563 | 4.75 | 5.94 | 7.13 | 8.31 | 9.50 | 10.69 | 11.88 | 13.06 | 14.25 | 15.44 | 16.63 | 17.81 | 19.00 |
| 20 | 1.250 | 2.500 | 3.750 | 5.00 | 6.25 | 7.50 | 8.75 | 10.00 | 11.25 | 12.50 | 13.75 | 15.00 | 16.25 | 17.50 | 18.75 | 20.00 |
| 21 | 1.313 | 2.625 | 3.938 | 5.25 | 6.56 | 7.88 | 9.19 | 10.50 | 11.81 | 13.13 | 14.44 | 15.75 | 17.06 | 18.38 | 19.69 | 21.00 |
| 22 | 1.375 | 2.750 | 4.125 | 5.50 | 6.88 | 8.25 | 9.63 | 11.00 | 12.38 | 13.75 | 15.13 | 16.50 | 17.88 | 19.25 | 20.63 | 22.00 |
| 23 | 1.438 | 2.875 | 4.313 | 5.75 | 7.19 | 8.63 | 10.06 | 11.50 | 12.94 | 14.38 | 15.81 | 17.25 | 18.69 | 20.13 | 21.56 | 23.00 |
| 24 | 1.500 | 3.000 | 4.500 | 6.00 | 7.50 | 9.00 | 10.50 | 12.00 | 13.50 | 15.00 | 16.50 | 18.00 | 19.50 | 21.00 | 22.50 | 24.00 |

# Weights and Areas

## Square and Round Bars and Circumferences of Round Bars

### Continued

| Side or Diameter, Inches | Weight of □ Bar per Foot | Weight of ○ Bar per Foot | Area of □ Bar Square Inches | Area of ○ Bar Square Inches | Circumference of ○ Bar Inches |
|---|---|---|---|---|---|
| 6 5/16 | 135.5 | 106.4 | 39.848 | 31.296 | 19.831 |
| 3/8 | 138.2 | 108.5 | 40.641 | 31.919 | 20.028 |
| 7/16 | 140.9 | 110.7 | 41.441 | 32.548 | 20.224 |
| 1/2 | 143.6 | 112.8 | 42.250 | 33.183 | 20.420 |
| 9/16 | 146.5 | 114.9 | 43.066 | 33.824 | 20.617 |
| 5/8 | 149.2 | 117.2 | 43.891 | 34.472 | 20.813 |
| 11/16 | 152.1 | 119.4 | 44.723 | 35.125 | 21.009 |
| 3/4 | 154.9 | 121.7 | 45.563 | 35.785 | 21.206 |
| 13/16 | 157.8 | 123.9 | 46.410 | 36.450 | 21.402 |
| 7/8 | 160.8 | 126.2 | 47.266 | 37.122 | 21.598 |
| 15/16 | 163.6 | 128.5 | 48.129 | 37.800 | 21.795 |
| 7 | 166.6 | 130.9 | 49.000 | 38.485 | 21.991 |
| 1/16 | 169.6 | 133.2 | 49.879 | 39.175 | 22.187 |
| 1/8 | 172.6 | 135.6 | 50.766 | 39.871 | 22.384 |
| 3/16 | 175.6 | 137.9 | 51.660 | 40.574 | 22.580 |
| 1/4 | 178.7 | 140.4 | 52.563 | 41.282 | 22.777 |
| 5/16 | 181.8 | 142.8 | 53.473 | 41.997 | 22.973 |
| 3/8 | 184.9 | 145.3 | 54.391 | 42.718 | 23.169 |
| 7/16 | 188.1 | 147.7 | 55.316 | 43.445 | 23.366 |
| 1/2 | 191.3 | 150.2 | 56.250 | 44.179 | 23.562 |
| 9/16 | 194.4 | 152.7 | 57.191 | 44.918 | 23.758 |
| 5/8 | 197.7 | 155.2 | 58.141 | 45.664 | 23.955 |
| 11/16 | 200.9 | 157.8 | 59.098 | 46.415 | 24.151 |
| 3/4 | 204.2 | 160.3 | 60.063 | 47.173 | 24.347 |
| 13/16 | 207.6 | 163.0 | 61.035 | 47.937 | 24.544 |
| 7/8 | 210.8 | 165.6 | 62.016 | 48.707 | 24.740 |
| 15/16 | 214.2 | 168.2 | 63.004 | 49.483 | 24.936 |
| 8 | 217.6 | 171.0 | 64.000 | 50.265 | 25.133 |

# Areas of Bars and Plates
## Square Inches

| Width, Inches | Thickness, Inches | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 |
| ½ | .031 | .063 | .094 | .125 | .156 | .188 | .219 | .25 | .28 | .31 | .34 | .38 | .41 | .44 | .47 | .50 |
| 1 | .063 | .125 | .188 | .250 | .313 | .375 | .438 | .50 | .56 | .63 | .69 | .75 | .81 | .88 | .94 | 1.00 |
| 2 | .125 | .250 | .375 | .500 | .625 | .750 | .875 | 1.00 | 1.13 | 1.25 | 1.38 | 1.50 | 1.63 | 1.75 | 1.88 | 2.00 |
| 3 | .188 | .375 | .563 | .750 | .938 | 1.125 | 1.313 | 1.50 | 1.69 | 1.88 | 2.06 | 2.25 | 2.44 | 2.63 | 2.81 | 3.00 |
| 4 | .250 | .500 | .750 | 1.000 | 1.250 | 1.500 | 1.750 | 2.00 | 2.25 | 2.50 | 2.75 | 3.00 | 3.25 | 3.50 | 3.75 | 4.00 |
| 5 | .313 | .625 | .938 | 1.250 | 1.563 | 1.875 | 2.188 | 2.50 | 2.81 | 3.13 | 3.44 | 3.75 | 4.06 | 4.38 | 4.69 | 5.00 |
| 6 | .375 | .750 | 1.125 | 1.500 | 1.875 | 2.250 | 2.625 | 3.00 | 3.38 | 3.75 | 4.13 | 4.50 | 4.88 | 5.25 | 5.63 | 6.00 |
| 7 | .438 | .875 | 1.313 | 1.750 | 2.188 | 2.625 | 3.063 | 3.50 | 3.94 | 4.38 | 4.81 | 5.25 | 5.69 | 6.13 | 6.56 | 7.00 |
| 8 | .500 | 1.000 | 1.500 | 2.000 | 2.500 | 3.000 | 3.500 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 | 7.50 | 8.00 |
| 9 | .563 | 1.125 | 1.688 | 2.250 | 2.813 | 3.375 | 3.938 | 4.50 | 5.06 | 5.63 | 6.19 | 6.75 | 7.31 | 7.88 | 8.44 | 9.00 |
| 10 | .625 | 1.250 | 1.875 | 2.50 | 3.13 | 3.75 | 4.38 | 5.00 | 5.63 | 6.25 | 6.88 | 7.50 | 8.13 | 8.75 | 9.38 | 10.00 |
| 11 | .688 | 1.375 | 2.063 | 2.75 | 3.44 | 4.13 | 4.81 | 5.50 | 6.19 | 6.88 | 7.56 | 8.25 | 8.94 | 9.63 | 10.31 | 11.00 |
| 12 | .750 | 1.500 | 2.250 | 3.00 | 3.75 | 4.50 | 5.25 | 6.00 | 6.75 | 7.50 | 8.25 | 9.00 | 9.75 | 10.50 | 11.25 | 12.00 |
| 13 | .813 | 1.625 | 2.438 | 3.25 | 4.06 | 4.88 | 5.69 | 6.50 | 7.31 | 8.13 | 8.94 | 9.75 | 10.56 | 11.38 | 12.19 | 13.00 |
| 14 | .875 | 1.750 | 2.625 | 3.50 | 4.38 | 5.25 | 6.13 | 7.00 | 7.88 | 8.75 | 9.63 | 10.50 | 11.38 | 12.25 | 13.13 | 14.00 |
| 15 | .938 | 1.875 | 2.813 | 3.75 | 4.69 | 5.63 | 6.56 | 7.50 | 8.44 | 9.38 | 10.31 | 11.25 | 12.19 | 13.13 | 14.06 | 15.00 |
| 16 | 1.000 | 2.000 | 3.000 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 |
| 17 | 1.063 | 2.125 | 3.188 | 4.25 | 5.31 | 6.38 | 7.44 | 8.50 | 9.56 | 10.63 | 11.69 | 12.75 | 13.81 | 14.88 | 15.94 | 17.00 |
| 18 | 1.125 | 2.250 | 3.375 | 4.50 | 5.63 | 6.75 | 7.88 | 9.00 | 10.13 | 11.25 | 12.38 | 13.50 | 14.63 | 15.75 | 16.88 | 18.00 |
| 19 | 1.188 | 2.375 | 3.563 | 4.75 | 5.94 | 7.13 | 8.31 | 9.50 | 10.69 | 11.88 | 13.06 | 14.25 | 15.44 | 16.63 | 17.81 | 19.00 |
| 20 | 1.250 | 2.500 | 3.750 | 5.00 | 6.25 | 7.50 | 8.75 | 10.00 | 11.25 | 12.50 | 13.75 | 15.00 | 16.25 | 17.50 | 18.75 | 20.00 |
| 21 | 1.313 | 2.625 | 3.938 | 5.25 | 6.56 | 7.88 | 9.19 | 10.50 | 11.81 | 13.13 | 14.44 | 15.75 | 17.06 | 18.38 | 19.69 | 21.00 |
| 22 | 1.375 | 2.750 | 4.125 | 5.50 | 6.88 | 8.25 | 9.63 | 11.00 | 12.38 | 13.75 | 15.13 | 16.50 | 17.88 | 19.25 | 20.63 | 22.00 |
| 23 | 1.438 | 2.875 | 4.313 | 5.75 | 7.19 | 8.63 | 10.06 | 11.50 | 12.94 | 14.38 | 15.81 | 17.25 | 18.69 | 20.13 | 21.56 | 23.00 |
| 24 | 1.500 | 3.000 | 4.500 | 6.00 | 7.50 | 9.00 | 10.50 | 12.00 | 13.50 | 15.00 | 16.50 | 18.00 | 19.50 | 21.00 | 22.50 | 24.00 |

# Areas of Bars and Plates
## Square Inches
### Continued

| Width, Inches | Thickness, Inches | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\frac{1}{16}$ | $\frac{1}{8}$ | $\frac{3}{16}$ | $\frac{1}{4}$ | $\frac{5}{16}$ | $\frac{3}{8}$ | $\frac{7}{16}$ | $\frac{1}{2}$ | $\frac{9}{16}$ | $\frac{5}{8}$ | $\frac{11}{16}$ | $\frac{3}{4}$ | $\frac{13}{16}$ | $\frac{7}{8}$ | $\frac{15}{16}$ | 1 |
| 25 | 1.563 | 3.125 | 4.688 | 6.25 | 7.81 | 9.38 | 10.94 | 12.50 | 14.06 | 15.63 | 17.19 | 18.75 | 20.31 | 21.88 | 23.44 | 25.00 |
| 26 | 1.625 | 3.250 | 4.875 | 6.50 | 8.13 | 9.75 | 11.38 | 13.00 | 14.63 | 16.25 | 17.88 | 19.50 | 21.13 | 22.75 | 24.38 | 26.00 |
| 27 | 1.688 | 3.375 | 5.063 | 6.75 | 8.44 | 10.13 | 11.81 | 13.50 | 15.19 | 16.88 | 18.56 | 20.25 | 21.94 | 23.63 | 25.31 | 27.00 |
| 28 | 1.750 | 3.500 | 5.250 | 7.00 | 8.75 | 10.50 | 12.25 | 14.00 | 15.75 | 17.50 | 19.25 | 21.00 | 22.75 | 24.50 | 26.25 | 28.00 |
| 29 | 1.813 | 3.625 | 5.438 | 7.25 | 9.06 | 10.88 | 12.69 | 14.50 | 16.31 | 18.13 | 19.94 | 21.75 | 23.56 | 25.38 | 27.19 | 29.00 |
| 30 | 1.875 | 3.750 | 5.625 | 7.50 | 9.38 | 11.25 | 13.13 | 15.00 | 16.88 | 18.75 | 20.63 | 22.50 | 24.38 | 26.25 | 28.13 | 30.00 |
| 31 | 1.938 | 3.875 | 5.813 | 7.75 | 9.69 | 11.63 | 13.56 | 15.50 | 17.44 | 19.38 | 21.31 | 23.25 | 25.19 | 27.13 | 29.06 | 31.00 |
| 32 | 2.000 | 4.000 | 6.000 | 8.00 | 10.00 | 12.00 | 14.00 | 16.00 | 18.00 | 20.00 | 22.00 | 24.00 | 26.00 | 28.00 | 30.00 | 32.00 |
| 33 | 2.063 | 4.125 | 6.188 | 8.25 | 10.31 | 12.38 | 14.44 | 16.50 | 18.56 | 20.63 | 22.69 | 24.75 | 26.81 | 28.88 | 30.94 | 33.00 |
| 34 | 2.125 | 4.250 | 6.375 | 8.50 | 10.63 | 12.75 | 14.88 | 17.00 | 19.13 | 21.25 | 23.38 | 25.50 | 27.63 | 29.75 | 31.88 | 34.00 |
| 35 | 2.188 | 4.375 | 6.563 | 8.75 | 10.94 | 13.13 | 15.31 | 17.50 | 19.69 | 21.88 | 24.06 | 26.25 | 28.44 | 30.63 | 32.81 | 35.00 |
| 36 | 2.250 | 4.500 | 6.750 | 9.00 | 11.25 | 13.50 | 15.75 | 18.00 | 20.25 | 22.50 | 24.75 | 27.00 | 29.25 | 31.50 | 33.75 | 36.00 |
| 37 | 2.313 | 4.625 | 6.938 | 9.25 | 11.56 | 13.88 | 16.19 | 18.50 | 20.81 | 23.13 | 25.44 | 27.75 | 30.06 | 32.38 | 34.69 | 37.00 |
| 38 | 2.375 | 4.750 | 7.125 | 9.50 | 11.88 | 14.25 | 16.63 | 19.00 | 21.38 | 23.75 | 26.13 | 28.50 | 30.88 | 33.25 | 35.63 | 38.00 |
| 39 | 2.438 | 4.875 | 7.313 | 9.75 | 12.19 | 14.63 | 17.06 | 19.50 | 21.94 | 24.38 | 26.81 | 29.25 | 31.69 | 34.13 | 36.56 | 39.00 |
| 40 | 2.500 | 5.000 | 7.500 | 10.00 | 12.50 | 15.00 | 17.50 | 20.00 | 22.50 | 25.00 | 27.50 | 30.00 | 32.50 | 35.00 | 37.50 | 40.00 |
| 41 | 2.563 | 5.125 | 7.688 | 10.25 | 12.81 | 15.38 | 17.94 | 20.50 | 23.06 | 25.63 | 28.19 | 30.75 | 33.31 | 35.88 | 38.44 | 41.00 |
| 42 | 2.625 | 5.250 | 7.875 | 10.50 | 13.13 | 15.75 | 18.38 | 21.00 | 23.63 | 26.25 | 28.88 | 31.50 | 34.13 | 36.75 | 39.38 | 42.00 |
| 43 | 2.688 | 5.375 | 8.063 | 10.75 | 13.44 | 16.13 | 18.81 | 21.50 | 24.19 | 26.88 | 29.56 | 32.25 | 34.94 | 37.63 | 40.31 | 43.00 |
| 44 | 2.750 | 5.500 | 8.250 | 11.00 | 13.75 | 16.50 | 19.25 | 22.00 | 24.75 | 27.50 | 30.25 | 33.00 | 35.75 | 38.50 | 41.25 | 44.00 |
| 45 | 2.813 | 5.625 | 8.438 | 11.25 | 14.06 | 16.88 | 19.69 | 22.50 | 25.31 | 28.13 | 30.94 | 33.75 | 36.56 | 39.38 | 42.19 | 45.00 |
| 46 | 2.875 | 5.750 | 8.625 | 11.50 | 14.38 | 17.25 | 20.13 | 23.00 | 25.88 | 28.75 | 31.63 | 34.50 | 37.38 | 40.25 | 43.13 | 46.00 |
| 47 | 2.938 | 5.875 | 8.813 | 11.75 | 14.69 | 17.63 | 20.56 | 23.50 | 26.44 | 29.38 | 32.31 | 35.25 | 38.19 | 41.13 | 44.06 | 47.00 |
| 48 | 3.000 | 6.000 | 9.000 | 12.00 | 15.00 | 18.00 | 21.00 | 24.00 | 27.00 | 30.00 | 33.00 | 36.00 | 39.00 | 42.00 | 45.00 | 48.00 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

| Thickness, Inches | Width, Inches: 1/32 | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 1 |
|---|---|---|---|---|---|---|---|---|---|
| 1/16 | .007 | .013 | .020 | .027 | .033 | .040 | .046 | .053 | .213 |
| 5/64 | .008 | .017 | .025 | .033 | .042 | .050 | .058 | .066 | .266 |
| 3/32 | .010 | .020 | .030 | .040 | .050 | .060 | .070 | .080 | .319 |
| 7/64 | .012 | .023 | .035 | .046 | .058 | .070 | .081 | .093 | .372 |
| 1/8 | .013 | .027 | .040 | .053 | .066 | .080 | .093 | .106 | .425 |
| 9/64 | .015 | .030 | .045 | .060 | .075 | .090 | .105 | .120 | .478 |
| 5/32 | .017 | .033 | .050 | .066 | .083 | .100 | .116 | .133 | .531 |
| 11/64 | .018 | .037 | .055 | .073 | .091 | .110 | .128 | .146 | .584 |
| 3/16 | .020 | .040 | .060 | .080 | .100 | .120 | .139 | .159 | .638 |
| 13/64 | .022 | .043 | .065 | .086 | .108 | .130 | .151 | .173 | .691 |
| 7/32 | .023 | .046 | .070 | .093 | .116 | .140 | .163 | .186 | .744 |
| 15/64 | .025 | .050 | .075 | .100 | .125 | .149 | .174 | .199 | .797 |
| 1/4 | .027 | .053 | .080 | .106 | .133 | .159 | .186 | .213 | .850 |
| 17/64 | .028 | .056 | .085 | .113 | .141 | .169 | .198 | .226 | .903 |
| 9/32 | .030 | .060 | .090 | .120 | .149 | .179 | .209 | .239 | .956 |
| 19/64 | .032 | .063 | .095 | .126 | .158 | .189 | .221 | .252 | 1.01 |
| 5/16 | .033 | .067 | .100 | .133 | .166 | .199 | .232 | .266 | 1.06 |
| 21/64 | .035 | .070 | .105 | .139 | .174 | .209 | .244 | .279 | 1.12 |
| 11/32 | .037 | .073 | .110 | .146 | .182 | .219 | .256 | .292 | 1.17 |
| 23/64 | .038 | .076 | .115 | .153 | .191 | .229 | .267 | .305 | 1.22 |
| 3/8 | .040 | .080 | .120 | .160 | .200 | .239 | .279 | .319 | 1.28 |
| 25/64 | .042 | .083 | .125 | .166 | .208 | .249 | .291 | .332 | 1.33 |
| 13/32 | .043 | .086 | .129 | .172 | .216 | .259 | .302 | .345 | 1.38 |
| 27/64 | .045 | .090 | .134 | .179 | .224 | .269 | .314 | .359 | 1.43 |
| 7/16 | .046 | .093 | .139 | .186 | .232 | .279 | .325 | .372 | 1.49 |
| 29/64 | .048 | .096 | .144 | .193 | .241 | .289 | .337 | .385 | 1.54 |
| 15/32 | .050 | .100 | .149 | .200 | .249 | .299 | .349 | .398 | 1.59 |
| 31/64 | .051 | .103 | .154 | .206 | .257 | .309 | .360 | .412 | 1.65 |
| 1/2 | .053 | .106 | .159 | .213 | .266 | .319 | .372 | .425 | 1.70 |
| 33/64 | .055 | .110 | .164 | .219 | .274 | .329 | .383 | .438 | 1.75 |
| 17/32 | .056 | .113 | .169 | .226 | .282 | .339 | .395 | .452 | 1.81 |
| 35/64 | .058 | .116 | .174 | .232 | .290 | .349 | .407 | .465 | 1.86 |
| 9/16 | .060 | .120 | .179 | .239 | .299 | .359 | .418 | .478 | 1.91 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 9/32 | 5/16 | 11/32 | 3/8 | 13/32 | 7/16 | 15/32 | 1/2 | 1 |
| 1/16 | .060 | .066 | .073 | .080 | .086 | .093 | .100 | .106 | .213 |
| 5/64 | .075 | .083 | .091 | .100 | .108 | .116 | .125 | .133 | .266 |
| 3/32 | .090 | .100 | .110 | .120 | .129 | .139 | .149 | .159 | .319 |
| 7/64 | .105 | .116 | .128 | .139 | .151 | .163 | .174 | .186 | .372 |
| 1/8 | .120 | .133 | .146 | .159 | .173 | .186 | .199 | .212 | .425 |
| 9/64 | .134 | .149 | .164 | .179 | .194 | .209 | .224 | .239 | .478 |
| 5/32 | .149 | .166 | .183 | .199 | .216 | .232 | .249 | .266 | .531 |
| 11/64 | .164 | .183 | .201 | .219 | .237 | .256 | .274 | .292 | .584 |
| 3/16 | .179 | .199 | .219 | .239 | .259 | .279 | .299 | .319 | .638 |
| 13/64 | .194 | .216 | .237 | .259 | .281 | .302 | .324 | .345 | .691 |
| 7/32 | .209 | .232 | .256 | .279 | .302 | .325 | .349 | .372 | .744 |
| 15/64 | .224 | .249 | .274 | .299 | .324 | .349 | .374 | .398 | .797 |
| 1/4 | .239 | .266 | .292 | .319 | .345 | .372 | .398 | .425 | .850 |
| 17/64 | .254 | .282 | .310 | .339 | .367 | .395 | .423 | .452 | .903 |
| 9/32 | .269 | .299 | .329 | .359 | .388 | .418 | .448 | .478 | .956 |
| 19/64 | .284 | .315 | .347 | .379 | .410 | .442 | .473 | .505 | 1.01 |
| 5/16 | .299 | .332 | .365 | .398 | .432 | .465 | .498 | .531 | 1.06 |
| 21/64 | .314 | .349 | .383 | .418 | .453 | .488 | .523 | .558 | 1.12 |
| 11/32 | .329 | .365 | .402 | .438 | .475 | .511 | .548 | .584 | 1.17 |
| 23/64 | .344 | .382 | .420 | .458 | .496 | .535 | .573 | .611 | 1.22 |
| 3/8 | .359 | .398 | .438 | .478 | .518 | .558 | .598 | .638 | 1.28 |
| 25/64 | .374 | .415 | .457 | .498 | .540 | .581 | .623 | .664 | 1.33 |
| 13/32 | .388 | .432 | .475 | .518 | .561 | .604 | .647 | .691 | 1.38 |
| 27/64 | .403 | .448 | .493 | .538 | .583 | .628 | .672 | .717 | 1.43 |
| 7/16 | .418 | .465 | .511 | .558 | .604 | .651 | .697 | .744 | 1.49 |
| 29/64 | .433 | .481 | .530 | .578 | .626 | .674 | .722 | .770 | 1.54 |
| 15/32 | .448 | .498 | .548 | .598 | .647 | .697 | .747 | .797 | 1.59 |
| 31/64 | .463 | .515 | .566 | .618 | .669 | .721 | .772 | .823 | 1.65 |
| 1/2 | .478 | .531 | .584 | .638 | .691 | .744 | .797 | .850 | 1.70 |
| 33/64 | .493 | .548 | .603 | .657 | .712 | .767 | .822 | .877 | 1.75 |
| 17/32 | .508 | .564 | .621 | .677 | .734 | .790 | .847 | .903 | 1.81 |
| 35/64 | .523 | .581 | .639 | .697 | .755 | .813 | .872 | .930 | 1.86 |
| 9/16 | .538 | .598 | .657 | .717 | .777 | .837 | .896 | .956 | 1.91 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

Continued

| Thickness, Inches | Width, Inches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 13/16 | 7/8 | 15/16 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 |
| 1/16 | .173 | .186 | .199 | .213 | .239 | .266 | .292 | .319 |
| 5/64 | .216 | .232 | .249 | .266 | .299 | .332 | .365 | .398 |
| 3/32 | .259 | .279 | .299 | .319 | .358 | .398 | .438 | .478 |
| 7/64 | .302 | .325 | .349 | .372 | .418 | .465 | .511 | .558 |
| 1/8 | .345 | .372 | .399 | .425 | .478 | .531 | .584 | .638 |
| 9/64 | .388 | .418 | .448 | .478 | .538 | .598 | .657 | .717 |
| 5/32 | .432 | .465 | .498 | .531 | .598 | .664 | .730 | .797 |
| 11/64 | .475 | .511 | .548 | .584 | .657 | .730 | .803 | .876 |
| 3/16 | .518 | .558 | .598 | .638 | .717 | .797 | .877 | .956 |
| 13/64 | .561 | .604 | .647 | .691 | .777 | .863 | .950 | 1.04 |
| 7/32 | .604 | .651 | .697 | .744 | .837 | .930 | 1.02 | 1.12 |
| 15/64 | .647 | .697 | .747 | .797 | .896 | .996 | 1.10 | 1.20 |
| 1/4 | .691 | .744 | .797 | .850 | .956 | 1.06 | 1.17 | 1.28 |
| 17/64 | .734 | .790 | .847 | .903 | 1.02 | 1.13 | 1.24 | 1.35 |
| 9/32 | .777 | .837 | .896 | .956 | 1.08 | 1.20 | 1.31 | 1.43 |
| 19/64 | .820 | .883 | .946 | 1.01 | 1.14 | 1.26 | 1.39 | 1.51 |
| 5/16 | .863 | .929 | .996 | 1.06 | 1.20 | 1.33 | 1.46 | 1.59 |
| 21/64 | .906 | .976 | 1.05 | 1.12 | 1.25 | 1.39 | 1.53 | 1.67 |
| 11/32 | .949 | 1.02 | 1.10 | 1.17 | 1.31 | 1.46 | 1.61 | 1.75 |
| 23/64 | .993 | 1.07 | 1.15 | 1.22 | 1.37 | 1.53 | 1.68 | 1.83 |
| 3/8 | 1.04 | 1.12 | 1.20 | 1.28 | 1.43 | 1.59 | 1.75 | 1.91 |
| 25/64 | 1.08 | 1.16 | 1.25 | 1.33 | 1.49 | 1.66 | 1.83 | 1.99 |
| 13/32 | 1.12 | 1.21 | 1.29 | 1.38 | 1.55 | 1.72 | 1.90 | 2.07 |
| 27/64 | 1.16 | 1.25 | 1.34 | 1.43 | 1.61 | 1.79 | 1.97 | 2.15 |
| 7/16 | 1.21 | 1.30 | 1.39 | 1.49 | 1.67 | 1.86 | 2.05 | 2.23 |
| 29/64 | 1.25 | 1.35 | 1.44 | 1.54 | 1.73 | 1.93 | 2.12 | 2.31 |
| 15/32 | 1.29 | 1.39 | 1.49 | 1.59 | 1.79 | 1.99 | 2.19 | 2.39 |
| 31/64 | 1.34 | 1.44 | 1.54 | 1.65 | 1.85 | 2.06 | 2.26 | 2.47 |
| 1/2 | 1.38 | 1.49 | 1.59 | 1.70 | 1.91 | 2.13 | 2.34 | 2.55 |
| 33/64 | 1.42 | 1.53 | 1.64 | 1.75 | 1.97 | 2.19 | 2.41 | 2.63 |
| 17/32 | 1.47 | 1.58 | 1.69 | 1.81 | 2.03 | 2.26 | 2.48 | 2.71 |
| 35/64 | 1.51 | 1.63 | 1.74 | 1.86 | 2.09 | 2.32 | 2.56 | 2.79 |
| 9/16 | 1.55 | 1.67 | 1.79 | 1.91 | 2.15 | 2.39 | 2.63 | 2.87 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

**Continued**

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 3 | 3¼ | 3½ | 3¾ | 4 | 4¼ | 4½ | 4¾ | 12 |
| 3/16 | 1.91 | 2.07 | 2.23 | 2.39 | 2.55 | 2.71 | 2.87 | 3.03 | 7.65 |
| ¼ | 2.55 | 2.76 | 2.98 | 3.19 | 3.40 | 3.61 | 3.83 | 4.04 | 10.20 |
| 5/16 | 3.19 | 3.45 | 3.72 | 3.99 | 4.25 | 4.52 | 4.78 | 5.05 | 12.75 |
| ⅜ | 3.83 | 4.15 | 4.47 | 4.78 | 5.10 | 5.42 | 5.74 | 6.06 | 15.30 |
| 7/16 | 4.46 | 4.83 | 5.20 | 5.58 | 5.95 | 6.32 | 6.70 | 7.07 | 17.85 |
| ½ | 5.10 | 5.53 | 5.95 | 6.38 | 6.80 | 7.22 | 7.65 | 8.08 | 20.40 |
| 9/16 | 5.74 | 6.22 | 6.70 | 7.17 | 7.65 | 8.13 | 8.61 | 9.09 | 22.95 |
| ⅝ | 6.38 | 6.91 | 7.44 | 7.97 | 8.50 | 9.03 | 9.57 | 10.10 | 25.50 |
| 11/16 | 7.02 | 7.60 | 8.18 | 8.76 | 9.35 | 9.93 | 10.52 | 11.11 | 28.05 |
| ¾ | 7.65 | 8.29 | 8.93 | 9.57 | 10.20 | 10.84 | 11.48 | 12.12 | 30.60 |
| 13/16 | 8.29 | 8.98 | 9.67 | 10.36 | 11.05 | 11.74 | 12.43 | 13.12 | 33.15 |
| ⅞ | 8.93 | 9.67 | 10.41 | 11.16 | 11.90 | 12.65 | 13.39 | 14.13 | 35.70 |
| 15/16 | 9.57 | 10.36 | 11.16 | 11.95 | 12.75 | 13.55 | 14.34 | 15.14 | 38.25 |
| 1 | 10.20 | 11.05 | 11.90 | 12.75 | 13.60 | 14.45 | 15.30 | 16.15 | 40.80 |
| 1 1/16 | 10.84 | 11.74 | 12.65 | 13.55 | 14.45 | 15.35 | 16.26 | 17.16 | 43.35 |
| 1⅛ | 11.48 | 12.43 | 13.39 | 14.34 | 15.30 | 16.26 | 17.22 | 18.17 | 45.90 |
| 1 3/16 | 12.12 | 13.12 | 14.13 | 15.14 | 16.15 | 17.16 | 18.17 | 19.18 | 48.45 |
| 1¼ | 12.75 | 13.81 | 14.87 | 15.94 | 17.00 | 18.06 | 19.13 | 20.19 | 51.00 |
| 1 5/16 | 13.39 | 14.50 | 15.62 | 16.74 | 17.85 | 18.96 | 20.08 | 21.20 | 53.55 |
| 1⅜ | 14.03 | 15.20 | 16.36 | 17.53 | 18.70 | 19.87 | 21.04 | 22.21 | 56.10 |
| 1 7/16 | 14.66 | 15.88 | 17.10 | 18.33 | 19.55 | 20.77 | 21.99 | 23.22 | 58.65 |
| 1½ | 15.30 | 16.58 | 17.85 | 19.13 | 20.40 | 21.68 | 22.95 | 24.23 | 61.20 |
| 1 9/16 | 15.94 | 17.27 | 18.60 | 19.92 | 21.25 | 22.58 | 23.91 | 25.24 | 63.75 |
| 1⅝ | 16.58 | 17.96 | 19.34 | 20.72 | 22.10 | 23.48 | 24.87 | 26.25 | 66.30 |
| 1 11/16 | 17.22 | 18.65 | 20.08 | 21.51 | 22.95 | 24.38 | 25.82 | 27.26 | 68.85 |
| 1¾ | 17.85 | 19.34 | 20.83 | 22.32 | 23.80 | 25.29 | 26.78 | 28.27 | 71.40 |
| 1 13/16 | 18.49 | 20.03 | 21.57 | 23.11 | 24.65 | 26.19 | 27.73 | 29.27 | 73.95 |
| 1⅞ | 19.13 | 20.72 | 22.31 | 23.91 | 25.50 | 27.10 | 28.69 | 30.28 | 76.50 |
| 1 15/16 | 19.77 | 21.41 | 23.06 | 24.70 | 26.35 | 28.00 | 29.64 | 31.29 | 79.05 |
| 2 | 20.40 | 22.10 | 23.80 | 25.50 | 27.20 | 28.90 | 30.60 | 32.30 | 81.60 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 5¼ | 5½ | 5¾ | 6 | 6¼ | 6½ | 6¾ | 12 |
| 3/16 | 3.19 | 3.35 | 3.51 | 3.67 | 3.83 | 3.99 | 4.14 | 4.30 | 7.65 |
| ¼ | 4.25 | 4.46 | 4.67 | 4.89 | 5.10 | 5.31 | 5.53 | 5.74 | 10.20 |
| 5/16 | 5.31 | 5.58 | 5.84 | 6.11 | 6.38 | 6.64 | 6.90 | 7.17 | 12.75 |
| ⅜ | 6.38 | 6.69 | 7.02 | 7.34 | 7.65 | 7.97 | 8.29 | 8.61 | 15.30 |
| 7/16 | 7.44 | 7.81 | 8.18 | 8.56 | 8.93 | 9.29 | 9.67 | 10.04 | 17.85 |
| ½ | 8.50 | 8.93 | 9.35 | 9.77 | 10.20 | 10.63 | 11.05 | 11.48 | 20.40 |
| 9/16 | 9.57 | 10.04 | 10.53 | 11.00 | 11.48 | 11.95 | 12.43 | 12.91 | 22.95 |
| ⅝ | 10.63 | 11.16 | 11.69 | 12.22 | 12.75 | 13.28 | 13.81 | 14.34 | 25.50 |
| 11/16 | 11.69 | 12.27 | 12.85 | 13.44 | 14.03 | 14.61 | 15.20 | 15.78 | 28.05 |
| ¾ | 12.75 | 13.39 | 14.03 | 14.67 | 15.30 | 15.94 | 16.58 | 17.22 | 30.60 |
| 13/16 | 13.81 | 14.50 | 15.19 | 15.88 | 16.58 | 17.27 | 17.95 | 18.65 | 33.15 |
| ⅞ | 14.87 | 15.62 | 16.36 | 17.10 | 17.85 | 18.60 | 19.34 | 20.08 | 35.70 |
| 15/16 | 15.94 | 16.74 | 17.53 | 18.33 | 19.13 | 19.92 | 20.72 | 21.51 | 38.25 |
| 1 | 17.00 | 17.85 | 18.70 | 19.55 | 20.40 | 21.25 | 22.10 | 22.95 | 40.80 |
| 1 1/16 | 18.06 | 18.96 | 19.87 | 20.77 | 21.68 | 22.58 | 23.48 | 24.39 | 43.35 |
| 1⅛ | 19.13 | 20.08 | 21.04 | 21.99 | 22.95 | 23.91 | 24.87 | 25.82 | 45.90 |
| 1 3/16 | 20.19 | 21.20 | 22.21 | 23.22 | 24.23 | 25.23 | 26.24 | 27.25 | 48.45 |
| 1¼ | 21.25 | 22.32 | 23.38 | 24.44 | 25.50 | 26.56 | 27.62 | 28.69 | 51.00 |
| 1 5/16 | 22.32 | 23.43 | 24.54 | 25.66 | 26.78 | 27.90 | 29.01 | 30.12 | 53.55 |
| 1⅜ | 23.38 | 24.54 | 25.71 | 26.88 | 28.05 | 29.22 | 30.39 | 31.56 | 56.10 |
| 1 7/16 | 24.44 | 25.66 | 26.88 | 28.10 | 29.33 | 30.55 | 31.77 | 32.99 | 58.65 |
| 1½ | 25.50 | 26.78 | 28.05 | 29.33 | 30.60 | 31.88 | 33.15 | 34.43 | 61.20 |
| 1 9/16 | 26.57 | 27.89 | 29.22 | 30.55 | 31.88 | 33.20 | 34.53 | 35.86 | 63.75 |
| 1⅝ | 27.63 | 29.01 | 30.39 | 31.77 | 33.15 | 34.53 | 35.91 | 37.29 | 66.30 |
| 1 11/16 | 28.69 | 30.12 | 31.55 | 32.99 | 34.43 | 35.86 | 37.30 | 38.73 | 68.85 |
| 1¾ | 29.75 | 31.24 | 32.73 | 34.22 | 35.70 | 37.19 | 38.68 | 40.17 | 71.40 |
| 1 13/16 | 30.81 | 32.35 | 33.89 | 35.43 | 36.98 | 38.52 | 40.05 | 41.60 | 73.95 |
| 1⅞ | 31.87 | 33.47 | 35.06 | 36.65 | 38.25 | 39.85 | 41.44 | 43.03 | 76.50 |
| 1 15/16 | 32.94 | 34.59 | 36.23 | 37.88 | 39.53 | 41.17 | 42.82 | 44.46 | 79.05 |
| 2 | 34.00 | 35.70 | 37.40 | 39.10 | 40.80 | 42.50 | 44.20 | 45.90 | 81.60 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7 | 7¼ | 7½ | 7¾ | 8 | 8¼ | 8½ | 8¾ | 12 |
| 3/16 | 4.46 | 4.62 | 4.78 | 4.94 | 5.10 | 5.26 | 5.42 | 5.58 | 7.65 |
| ¼ | 5.95 | 6.16 | 6.36 | 6.58 | 6.80 | 7.01 | 7.22 | 7.43 | 10.20 |
| 5/16 | 7.44 | 7.70 | 7.97 | 8.23 | 8.50 | 8.76 | 9.03 | 9.29 | 12.75 |
| ⅜ | 8.93 | 9.25 | 9.57 | 9.88 | 10.20 | 10.52 | 10.84 | 11.16 | 15.30 |
| 7/16 | 10.41 | 10.78 | 11.16 | 11.53 | 11.90 | 12.27 | 12.64 | 13.02 | 17.85 |
| ½ | 11.90 | 12.32 | 12.75 | 13.18 | 13.60 | 14.03 | 14.44 | 14.87 | 20.40 |
| 9/16 | 13.39 | 13.86 | 14.34 | 14.82 | 15.30 | 15.78 | 16.26 | 16.74 | 22.95 |
| ⅝ | 14.87 | 15.40 | 15.94 | 16.47 | 17.00 | 17.53 | 18.06 | 18.59 | 25.50 |
| 11/16 | 16.36 | 16.94 | 17.53 | 18.12 | 18.70 | 19.28 | 19.86 | 20.45 | 28.05 |
| ¾ | 17.85 | 18.49 | 19.13 | 19.77 | 20.40 | 21.04 | 21.68 | 22.32 | 30.60 |
| 13/16 | 19.34 | 20.03 | 20.72 | 21.41 | 22.10 | 22.79 | 23.48 | 24.17 | 33.15 |
| ⅞ | 20.83 | 21.57 | 22.32 | 23.05 | 23.80 | 24.55 | 25.30 | 26.04 | 35.70 |
| 15/16 | 22.32 | 23.11 | 23.91 | 24.70 | 25.50 | 26.30 | 27.10 | 27.89 | 38.25 |
| 1 | 23.80 | 24.65 | 25.50 | 26.35 | 27.20 | 28.05 | 28.90 | 29.75 | 40.80 |
| 1 1/16 | 25.29 | 26.19 | 27.10 | 28.00 | 28.90 | 29.80 | 30.70 | 31.61 | 43.35 |
| 1⅛ | 26.78 | 27.73 | 28.68 | 29.64 | 30.60 | 31.56 | 32.52 | 33.47 | 45.90 |
| 1 3/16 | 28.26 | 29.27 | 30.28 | 31.29 | 32.30 | 33.31 | 34.32 | 35.33 | 48.45 |
| 1¼ | 29.75 | 30.81 | 31.88 | 32.94 | 34.00 | 35.06 | 36.12 | 37.20 | 51.00 |
| 1 5/16 | 31.23 | 32.35 | 33.48 | 34.59 | 35.70 | 36.81 | 37.93 | 39.05 | 53.55 |
| 1⅜ | 32.72 | 33.89 | 35.06 | 36.23 | 37.40 | 38.57 | 39.74 | 40.91 | 56.10 |
| 1 7/16 | 34.21 | 35.44 | 36.66 | 37.88 | 39.10 | 40.32 | 41.54 | 42.77 | 58.65 |
| 1½ | 35.70 | 36.98 | 38.26 | 39.53 | 40.80 | 42.08 | 43.35 | 44.63 | 61.20 |
| 1 9/16 | 37.19 | 38.51 | 39.84 | 41.17 | 42.50 | 43.83 | 45.16 | 46.49 | 63.75 |
| 1⅝ | 38.67 | 40.05 | 41.44 | 42.82 | 44.20 | 45.58 | 46.96 | 48.34 | 66.30 |
| 1 11/16 | 40.16 | 41.59 | 43.03 | 44.47 | 45.90 | 47.33 | 48.76 | 50.20 | 68.85 |
| 1¾ | 41.65 | 43.14 | 44.63 | 46.12 | 47.60 | 49.09 | 50.58 | 52.07 | 71.40 |
| 1 13/16 | 43.14 | 44.68 | 46.22 | 47.76 | 49.30 | 50.84 | 52.38 | 53.92 | 73.95 |
| 1⅞ | 44.63 | 46.22 | 47.82 | 49.40 | 51.00 | 52.60 | 54.20 | 55.79 | 76.50 |
| 1 15/16 | 46.12 | 47.76 | 49.41 | 51.05 | 52.70 | 54.35 | 56.00 | 57.60 | 79.05 |
| 2 | 47.60 | 49.30 | 51.00 | 52.70 | 54.40 | 56.10 | 57.80 | 59.50 | 81.60 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

Continued

| Thickness, Inches | Width, Inches 9 | 9¼ | 9½ | 9¾ | 10 | 10¼ | 10½ | 10¾ | 12 |
|---|---|---|---|---|---|---|---|---|---|
| 3/16 | 5.74 | 5.90 | 6.06 | 6.22 | 6.38 | 6.54 | 6.70 | 6.86 | 7.65 |
| ¼ | 7.65 | 7.86 | 8.08 | 8.29 | 8.50 | 8.71 | 8.92 | 9.14 | 10.20 |
| 5/16 | 9.56 | 9.83 | 10.10 | 10.36 | 10.62 | 10.89 | 11.16 | 11.42 | 12.75 |
| ⅜ | 11.48 | 11.80 | 12.12 | 12.44 | 12.75 | 13.07 | 13.39 | 13.71 | 15.30 |
| 7/16 | 13.40 | 13.76 | 14.14 | 14.51 | 14.88 | 15.25 | 15.62 | 15.99 | 17.85 |
| ½ | 15.30 | 15.73 | 16.16 | 16.58 | 17.00 | 17.42 | 17.85 | 18.28 | 20.40 |
| 9/16 | 17.22 | 17.69 | 18.18 | 18.65 | 19.14 | 19.61 | 20.08 | 20.56 | 22.95 |
| ⅝ | 19.13 | 19.65 | 20.19 | 20.72 | 21.25 | 21.78 | 22.32 | 22.85 | 25.50 |
| 11/16 | 21.04 | 21.62 | 22.21 | 22.79 | 23.38 | 23.96 | 24.54 | 25.13 | 28.05 |
| ¾ | 22.96 | 23.59 | 24.23 | 24.86 | 25.50 | 26.14 | 26.78 | 27.42 | 30.60 |
| 13/16 | 24.86 | 25.55 | 26.24 | 26.94 | 27.62 | 28.32 | 29.00 | 29.69 | 33.15 |
| ⅞ | 26.78 | 27.52 | 28.26 | 29.01 | 29.75 | 30.50 | 31.24 | 31.98 | 35.70 |
| 15/16 | 28.69 | 29.49 | 30.28 | 31.08 | 31.88 | 32.67 | 33.48 | 34.28 | 38.25 |
| 1 | 30.60 | 31.45 | 32.30 | 33.15 | 34.00 | 34.85 | 35.70 | 36.55 | 40.80 |
| 1 1/16 | 32.52 | 33.41 | 34.32 | 35.22 | 36.12 | 37.03 | 37.92 | 38.83 | 43.35 |
| 1⅛ | 34.43 | 35.38 | 36.34 | 37.29 | 38.25 | 39.21 | 40.17 | 41.12 | 45.90 |
| 1 3/16 | 36.34 | 37.35 | 38.36 | 39.37 | 40.38 | 41.39 | 42.40 | 43.40 | 48.45 |
| 1¼ | 38.26 | 39.31 | 40.37 | 41.44 | 42.50 | 43.56 | 44.63 | 45.69 | 51.00 |
| 1 5/16 | 40.16 | 41.28 | 42.40 | 43.52 | 44.64 | 45.75 | 46.86 | 47.97 | 53.55 |
| 1⅜ | 42.08 | 43.25 | 44.41 | 45.58 | 46.75 | 47.92 | 49.08 | 50.25 | 56.10 |
| 1 7/16 | 44.00 | 45.22 | 46.44 | 47.66 | 48.88 | 50.10 | 51.32 | 52.54 | 58.65 |
| 1½ | 45.90 | 47.18 | 48.45 | 49.73 | 51.00 | 52.28 | 53.55 | 54.83 | 61.20 |
| 1 9/16 | 47.82 | 49.14 | 50.48 | 51.80 | 53.14 | 54.46 | 55.78 | 57.11 | 63.75 |
| 1⅝ | 49.73 | 51.10 | 52.49 | 53.87 | 55.25 | 56.63 | 58.02 | 59.40 | 66.30 |
| 1 11/16 | 51.64 | 53.07 | 54.51 | 55.94 | 57.38 | 58.81 | 60.24 | 61.68 | 68.85 |
| 1¾ | 53.56 | 55.04 | 56.53 | 58.01 | 59.50 | 60.99 | 62.48 | 63.97 | 71.40 |
| 1 13/16 | 55.46 | 57.00 | 58.54 | 60.09 | 61.62 | 63.17 | 64.70 | 66.24 | 73.95 |
| 1⅞ | 57.38 | 58.97 | 60.56 | 62.16 | 63.75 | 65.35 | 66.94 | 68.53 | 76.50 |
| 1 15/16 | 59.29 | 60.94 | 62.58 | 64.23 | 65.88 | 67.52 | 69.18 | 70.83 | 79.05 |
| 2 | 61.20 | 62.90 | 64.60 | 66.30 | 68.00 | 69.70 | 71.40 | 73.10 | 81.60 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 11 | 11¼ | 11½ | 11¾ | 12 | 12¼ | 12½ | 12¾ |
| 3/16 | 7.02 | 7.17 | 7.32 | 7.49 | 7.65 | 7.82 | 7.98 | 8.13 |
| ¼ | 9.34 | 9.57 | 9.78 | 10.00 | 10.20 | 10.42 | 10.63 | 10.84 |
| 5/16 | 11.68 | 11.95 | 12.22 | 12.49 | 12.75 | 13.01 | 13.28 | 13.55 |
| ⅜ | 14.03 | 14.35 | 14.68 | 14.99 | 15.30 | 15.62 | 15.94 | 16.26 |
| 7/16 | 16.36 | 16.74 | 17.12 | 17.49 | 17.85 | 18.23 | 18.60 | 18.97 |
| ½ | 18.70 | 19.13 | 19.55 | 19.97 | 20.40 | 20.82 | 21.25 | 21.67 |
| 9/16 | 21.02 | 21.51 | 22.00 | 22.48 | 22.95 | 23.43 | 23.90 | 24.39 |
| ⅝ | 23.38 | 23.91 | 24.44 | 24.97 | 25.50 | 26.03 | 26.56 | 27.09 |
| 11/16 | 25.70 | 26.30 | 26.88 | 27.47 | 28.05 | 28.64 | 29.22 | 29.80 |
| ¾ | 28.05 | 28.68 | 29.33 | 29.97 | 30.60 | 31.25 | 31.88 | 32.52 |
| 13/16 | 30.40 | 31.08 | 31.76 | 32.46 | 33.15 | 33.83 | 34.53 | 35.22 |
| ⅞ | 32.72 | 33.47 | 34.21 | 34.95 | 35.70 | 36.44 | 37.19 | 37.93 |
| 15/16 | 35.06 | 35.86 | 36.66 | 37.46 | 38.25 | 39.05 | 39.84 | 40.64 |
| 1 | 37.40 | 38.25 | 39.10 | 39.95 | 40.80 | 41.65 | 42.50 | 43.35 |
| 1 1/16 | 39.74 | 40.64 | 41.54 | 42.45 | 43.35 | 44.25 | 45.16 | 46.06 |
| 1⅛ | 42.08 | 43.04 | 44.00 | 44.94 | 45.90 | 46.86 | 47.82 | 48.77 |
| 1 3/16 | 44.42 | 45.42 | 46.44 | 47.45 | 48.45 | 49.46 | 50.46 | 51.48 |
| 1¼ | 46.76 | 47.82 | 48.88 | 49.94 | 51.00 | 52.06 | 53.12 | 54.19 |
| 1 5/16 | 49.08 | 50.20 | 51.32 | 52.44 | 53.55 | 54.67 | 55.78 | 56.90 |
| 1⅜ | 51.42 | 52.59 | 53.76 | 54.93 | 56.10 | 57.27 | 58.44 | 59.60 |
| 1 7/16 | 53.76 | 54.99 | 56.21 | 57.43 | 58.65 | 59.87 | 61.10 | 62.32 |
| 1½ | 56.10 | 57.37 | 58.65 | 59.93 | 61.20 | 62.48 | 63.75 | 65.03 |
| 1 9/16 | 58.42 | 59.76 | 61.10 | 62.43 | 63.75 | 65.08 | 66.40 | 67.74 |
| 1⅝ | 60.78 | 62.16 | 63.54 | 64.92 | 66.30 | 67.68 | 69.06 | 70.44 |
| 1 11/16 | 63.10 | 64.55 | 65.98 | 67.42 | 68.85 | 70.29 | 71.72 | 73.15 |
| 1¾ | 65.45 | 66.93 | 68.43 | 69.92 | 71.40 | 72.90 | 74.38 | 75.87 |
| 1 13/16 | 67.80 | 69.33 | 70.86 | 72.41 | 73.95 | 75.48 | 77.03 | 78.57 |
| 1⅞ | 70.12 | 71.72 | 73.31 | 74.90 | 76.50 | 78.09 | 79.69 | 81.28 |
| 1 15/16 | 72.46 | 74.11 | 75.76 | 77.41 | 79.05 | 80.70 | 82.34 | 83.99 |
| 2 | 74.80 | 76.50 | 78.20 | 79.90 | 81.60 | 83.30 | 85.00 | 86.70 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|
| 3/16 | 8.28 | 8.92 | 9.56 | 10.20 | 10.84 | 11.48 | 12.10 | 12.76 | 13.40 |
| 1/4 | 11.06 | 11.90 | 12.75 | 13.60 | 14.44 | 15.30 | 16.16 | 17.00 | 17.84 |
| 5/16 | 13.81 | 14.88 | 15.94 | 17.00 | 18.06 | 19.12 | 20.20 | 21.24 | 22.32 |
| 3/8 | 16.58 | 17.86 | 19.14 | 20.40 | 21.68 | 22.96 | 24.24 | 25.50 | 26.78 |
| 7/16 | 19.34 | 20.82 | 22.32 | 23.80 | 25.28 | 26.79 | 28.28 | 29.75 | 31.24 |
| 1/2 | 22.10 | 23.80 | 25.50 | 27.20 | 28.89 | 30.60 | 32.31 | 34.00 | 35.70 |
| 9/16 | 24.86 | 26.78 | 28.70 | 30.60 | 32.52 | 34.44 | 36.34 | 38.27 | 40.16 |
| 5/8 | 27.62 | 29.74 | 31.88 | 34.00 | 36.12 | 38.25 | 40.37 | 42.50 | 44.64 |
| 11/16 | 30.39 | 32.72 | 35.06 | 37.40 | 39.72 | 42.08 | 44.42 | 46.74 | 49.08 |
| 3/4 | 33.16 | 35.71 | 38.26 | 40.80 | 43.36 | 45.92 | 48.46 | 51.00 | 53.56 |
| 13/16 | 35.91 | 38.67 | 41.43 | 44.20 | 46.96 | 49.72 | 52.48 | 55.25 | 58.01 |
| 7/8 | 38.68 | 41.65 | 44.62 | 47.60 | 50.60 | 53.56 | 56.52 | 59.50 | 62.49 |
| 15/16 | 41.44 | 44.63 | 47.82 | 51.00 | 54.20 | 57.38 | 60.57 | 63.76 | 66.96 |
| 1 | 44.20 | 47.60 | 51.00 | 54.40 | 57.80 | 61.20 | 64.60 | 68.00 | 71.40 |
| 1 1/16 | 46.96 | 50.57 | 54.20 | 57.80 | 61.40 | 65.02 | 68.64 | 72.25 | 75.85 |
| 1 1/8 | 49.72 | 53.55 | 57.37 | 61.20 | 65.04 | 68.85 | 72.68 | 76.50 | 80.33 |
| 1 3/16 | 52.48 | 56.52 | 60.56 | 64.60 | 68.64 | 72.68 | 76.72 | 80.75 | 84.79 |
| 1 1/4 | 55.25 | 59.50 | 63.76 | 68.00 | 72.26 | 76.50 | 80.74 | 85.00 | 89.26 |
| 1 5/16 | 58.02 | 62.47 | 66.95 | 71.40 | 75.86 | 80.33 | 84.80 | 89.28 | 93.72 |
| 1 3/8 | 60.77 | 65.45 | 70.12 | 74.80 | 79.48 | 84.15 | 88.83 | 93.50 | 98.17 |
| 1 7/16 | 63.54 | 68.42 | 73.32 | 78.20 | 83.08 | 88.00 | 92.88 | 97.75 | 102.65 |
| 1 1/2 | 66.30 | 71.40 | 76.51 | 81.60 | 86.70 | 91.80 | 96.90 | 102.00 | 107.10 |
| 1 9/16 | 69.06 | 74.38 | 79.69 | 85.00 | 90.31 | 95.63 | 100.94 | 106.25 | 111.56 |
| 1 5/8 | 71.83 | 77.35 | 82.88 | 88.40 | 93.93 | 99.45 | 104.98 | 110.50 | 116.03 |
| 1 11/16 | 74.59 | 80.33 | 86.06 | 91.80 | 97.54 | 103.28 | 109.01 | 114.75 | 120.49 |
| 1 3/4 | 77.35 | 83.30 | 89.25 | 95.20 | 101.15 | 107.10 | 113.05 | 119.00 | 124.95 |
| 1 13/16 | 80.11 | 86.28 | 92.44 | 98.60 | 104.76 | 110.93 | 117.09 | 123.25 | 129.41 |
| 1 7/8 | 82.88 | 89.25 | 95.63 | 102.00 | 108.38 | 114.75 | 121.13 | 127.50 | 133.88 |
| 1 15/16 | 85.64 | 92.23 | 98.81 | 105.40 | 111.99 | 118.58 | 125.16 | 131.75 | 138.34 |
| 2 | 88.40 | 95.20 | 102.00 | 108.80 | 115.60 | 122.40 | 129.20 | 136.00 | 142.80 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

**Continued**

| Thickness, Inches | Width, Inches 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|
| 3/16 | 14.04 | 14.64 | 15.32 | 15.96 | 16.56 | 17.20 | 17.84 | 18.48 | 19.12 |
| 1/4 | 18.69 | 19.56 | 20.40 | 21.26 | 22.12 | 22.96 | 23.80 | 24.64 | 25.50 |
| 5/16 | 23.36 | 24.44 | 25.52 | 26.56 | 27.62 | 28.68 | 29.76 | 30.80 | 31.88 |
| 3/8 | 28.06 | 29.33 | 30.60 | 31.88 | 33.16 | 34.44 | 35.72 | 37.00 | 38.28 |
| 7/16 | 32.72 | 34.24 | 35.72 | 37.20 | 38.68 | 40.17 | 41.65 | 43.14 | 44.64 |
| 1/2 | 37.40 | 39.10 | 40.80 | 42.50 | 44.20 | 45.92 | 47.60 | 49.28 | 51.00 |
| 9/16 | 42.04 | 44.00 | 45.92 | 47.80 | 49.73 | 51.64 | 53.56 | 55.48 | 57.40 |
| 5/8 | 46.76 | 48.88 | 51.00 | 53.12 | 55.24 | 57.37 | 59.49 | 61.60 | 63.76 |
| 11/16 | 51.40 | 53.76 | 56.12 | 58.44 | 60.78 | 63.11 | 65.44 | 67.77 | 70.13 |
| 3/4 | 56.10 | 58.66 | 61.20 | 63.76 | 66.32 | 68.88 | 71.42 | 73.97 | 76.53 |
| 13/16 | 60.79 | 63.53 | 66.29 | 69.06 | 71.82 | 74.58 | 77.34 | 80.10 | 82.86 |
| 7/8 | 65.44 | 68.43 | 71.40 | 74.38 | 77.36 | 80.33 | 83.30 | 86.29 | 89.24 |
| 15/16 | 70.13 | 73.32 | 76.50 | 79.68 | 82.88 | 86.07 | 89.26 | 92.44 | 95.64 |
| 1 | 74.80 | 78.20 | 81.60 | 85.00 | 88.40 | 91.80 | 95.20 | 98.60 | 102.00 |
| 1 1/16 | 79.48 | 83.08 | 86.70 | 90.32 | 93.92 | 97.54 | 101.14 | 104.75 | 108.38 |
| 1 1/8 | 84.16 | 88.00 | 91.80 | 95.64 | 99.44 | 103.26 | 107.10 | 110.92 | 114.74 |
| 1 3/16 | 88.83 | 92.88 | 96.92 | 100.92 | 104.96 | 109.01 | 113.05 | 117.09 | 121.13 |
| 1 1/4 | 93.52 | 97.76 | 102.00 | 106.24 | 110.50 | 114.76 | 119.00 | 123.24 | 127.51 |
| 1 5/16 | 98.16 | 102.64 | 107.12 | 111.56 | 116.04 | 120.50 | 124.94 | 129.40 | 133.89 |
| 1 3/8 | 102.84 | 107.52 | 112.20 | 116.88 | 121.54 | 126.22 | 130.90 | 135.58 | 140.24 |
| 1 7/16 | 107.52 | 112.42 | 117.30 | 122.20 | 127.08 | 131.96 | 136.84 | 141.76 | 146.64 |
| 1 1/2 | 112.20 | 117.30 | 122.40 | 127.50 | 132.60 | 137.72 | 142.80 | 147.92 | 153.02 |
| 1 9/16 | 116.88 | 122.19 | 127.50 | 132.81 | 138.13 | 143.44 | 148.75 | 154.06 | 159.38 |
| 1 5/8 | 121.55 | 127.08 | 132.60 | 138.13 | 143.65 | 149.18 | 154.70 | 160.23 | 165.75 |
| 1 11/16 | 126.23 | 131.96 | 137.70 | 143.44 | 149.18 | 154.91 | 160.65 | 166.39 | 172.13 |
| 1 3/4 | 130.90 | 136.85 | 142.80 | 148.75 | 154.70 | 160.65 | 166.60 | 172.55 | 178.50 |
| 1 13/16 | 135.58 | 141.74 | 147.90 | 154.06 | 160.23 | 166.39 | 172.55 | 178.71 | 184.88 |
| 1 7/8 | 140.25 | 146.63 | 153.00 | 159.38 | 165.75 | 172.13 | 178.50 | 184.88 | 191.25 |
| 1 15/16 | 144.93 | 151.51 | 158.10 | 164.69 | 171.28 | 177.86 | 184.45 | 191.04 | 197.63 |
| 2 | 149.60 | 156.40 | 163.20 | 170.00 | 176.80 | 183.60 | 190.40 | 197.20 | 204.00 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

### Continued

| Thickness, Inches | Width, Inches 31 | 32 | 33 | 34 | 35 | 36 | 38 | 40 | 42 |
|---|---|---|---|---|---|---|---|---|---|
| 3/16 | 19.75 | 20.40 | 21.04 | 21.68 | 22.32 | 22.96 | 24.20 | 25.52 | 26.80 |
| 1/4 | 26.36 | 27.20 | 28.04 | 28.88 | 29.72 | 30.59 | 32.32 | 34.00 | 35.68 |
| 5/16 | 32.94 | 34.00 | 35.04 | 36.12 | 37.16 | 38.24 | 40.39 | 42.48 | 44.64 |
| 3/8 | 39.54 | 40.80 | 42.08 | 43.36 | 44.64 | 45.92 | 48.48 | 51.00 | 53.56 |
| 7/16 | 46.12 | 47.60 | 49.08 | 50.57 | 52.07 | 53.58 | 56.56 | 59.50 | 62.48 |
| 1/2 | 52.70 | 54.40 | 56.10 | 57.78 | 59.50 | 61.20 | 64.62 | 68.00 | 71.40 |
| 9/16 | 59.32 | 61.22 | 63.12 | 65.04 | 66.96 | 68.88 | 72.68 | 76.54 | 80.32 |
| 5/8 | 65.88 | 68.00 | 70.13 | 72.24 | 74.36 | 76.50 | 80.74 | 85.00 | 89.28 |
| 11/16 | 72.48 | 74.80 | 77.12 | 79.44 | 81.79 | 84.15 | 88.84 | 93.48 | 98.16 |
| 3/4 | 79.08 | 81.61 | 84.16 | 86.72 | 89.28 | 91.84 | 96.92 | 102.00 | 107.12 |
| 13/16 | 85.62 | 88.39 | 91.15 | 93.91 | 96.68 | 99.44 | 104.96 | 110.50 | 116.02 |
| 7/8 | 92.20 | 95.20 | 98.20 | 101.20 | 104.16 | 107.12 | 113.04 | 119.00 | 124.98 |
| 15/16 | 98.82 | 102.00 | 105.20 | 108.40 | 111.59 | 114.76 | 121.14 | 127.52 | 133.92 |
| 1 | 105.40 | 108.80 | 112.20 | 115.60 | 119.00 | 122.40 | 129.20 | 136.00 | 142.80 |
| 1 1/16 | 112.00 | 115.59 | 119.20 | 122.80 | 126.42 | 130.04 | 137.28 | 144.50 | 151.70 |
| 1 1/8 | 118.56 | 122.40 | 126.24 | 130.08 | 133.90 | 137.70 | 145.36 | 153.00 | 160.66 |
| 1 3/16 | 125.16 | 129.21 | 133.24 | 137.28 | 141.32 | 145.36 | 153.44 | 161.50 | 169.58 |
| 1 1/4 | 131.76 | 136.00 | 140.28 | 144.52 | 148.76 | 153.00 | 161.48 | 170.00 | 178.52 |
| 1 5/16 | 138.36 | 142.81 | 147.24 | 151.72 | 156.20 | 160.66 | 169.60 | 178.56 | 187.44 |
| 1 3/8 | 144.92 | 149.60 | 154.28 | 158.96 | 163.62 | 168.30 | 177.66 | 187.00 | 196.34 |
| 1 7/16 | 151.52 | 156.40 | 161.28 | 166.16 | 171.08 | 176.00 | 185.75 | 195.50 | 205.29 |
| 1 1/2 | 158.11 | 163.20 | 168.32 | 173.40 | 178.51 | 183.60 | 193.80 | 204.00 | 214.20 |
| 1 9/16 | 164.69 | 170.00 | 175.31 | 180.63 | 185.94 | 191.25 | 201.88 | 212.50 | 223.13 |
| 1 5/8 | 171.28 | 176.80 | 182.33 | 187.85 | 193.38 | 198.90 | 209.95 | 221.00 | 232.05 |
| 1 11/16 | 177.86 | 183.60 | 189.34 | 195.08 | 200.81 | 206.55 | 218.03 | 229.50 | 240.98 |
| 1 3/4 | 184.45 | 190.40 | 196.35 | 202.30 | 208.25 | 214.20 | 226.10 | 238.00 | 249.90 |
| 1 13/16 | 191.04 | 197.20 | 203.36 | 209.53 | 215.69 | 221.85 | 234.18 | 246.50 | 258.83 |
| 1 7/8 | 197.63 | 204.00 | 210.38 | 216.75 | 223.13 | 229.50 | 242.25 | 255.00 | 267.75 |
| 1 15/16 | 204.21 | 210.80 | 217.39 | 223.98 | 230.56 | 237.15 | 250.33 | 263.50 | 276.68 |
| 2 | 210.80 | 217.60 | 224.40 | 231.20 | 238.00 | 244.80 | 258.40 | 272.00 | 285.60 |

# Weights of Flat Rolled Steel

## Per Lineal Foot

Continued

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 44 | 46 | 48 | 50 | 52 | 54 | 56 | 58 | 60 |
| 3/16 | 28.08 | 29.29 | 30.64 | 31.92 | 33.12 | 34.40 | 35.68 | 36.96 | 38.24 |
| 1/4 | 37.38 | 39.11 | 40.80 | 42.52 | 44.24 | 45.92 | 47.60 | 49.28 | 51.00 |
| 5/16 | 46.72 | 48.88 | 51.04 | 53.12 | 55.24 | 57.36 | 59.51 | 61.60 | 63.76 |
| 3/8 | 56.12 | 58.65 | 61.20 | 63.76 | 66.32 | 68.88 | 71.44 | 74.00 | 76.56 |
| 7/16 | 65.44 | 68.47 | 71.44 | 74.40 | 77.37 | 80.34 | 83.30 | 86.28 | 89.28 |
| 1/2 | 74.80 | 78.20 | 81.60 | 85.00 | 88.40 | 91.84 | 95.20 | 98.56 | 102.00 |
| 9/16 | 84.09 | 88.00 | 91.84 | 95.60 | 99.46 | 103.28 | 107.12 | 110.96 | 114.80 |
| 5/8 | 93.52 | 97.76 | 102.00 | 106.24 | 110.48 | 114.74 | 118.98 | 123.20 | 127.52 |
| 11/16 | 102.81 | 107.53 | 112.24 | 116.88 | 121.56 | 126.22 | 130.88 | 135.54 | 140.26 |
| 3/4 | 112.20 | 117.31 | 122.40 | 127.52 | 132.64 | 137.76 | 142.85 | 147.94 | 153.06 |
| 13/16 | 121.56 | 127.06 | 132.58 | 138.12 | 143.64 | 149.16 | 154.68 | 160.20 | 165.72 |
| 7/8 | 130.89 | 136.86 | 142.80 | 148.76 | 154.72 | 160.66 | 166.60 | 172.58 | 178.48 |
| 15/16 | 140.27 | 146.64 | 153.00 | 159.36 | 165.76 | 172.15 | 178.52 | 184.88 | 191.28 |
| 1 | 149.60 | 156.40 | 163.20 | 170.00 | 176.80 | 183.60 | 190.40 | 197.20 | 204.00 |
| 1 1/16 | 158.96 | 166.16 | 173.40 | 180.64 | 187.84 | 195.08 | 202.28 | 209.50 | 216.76 |
| 1 1/8 | 168.32 | 175.99 | 183.60 | 191.28 | 198.88 | 206.52 | 214.20 | 221.84 | 229.48 |
| 1 3/16 | 177.66 | 185.76 | 193.84 | 201.84 | 209.92 | 218.02 | 226.10 | 234.18 | 242.26 |
| 1 1/4 | 187.04 | 195.52 | 204.00 | 212.48 | 221.00 | 229.52 | 238.00 | 246.48 | 255.02 |
| 1 5/16 | 196.32 | 205.28 | 214.24 | 223.12 | 232.08 | 241.00 | 249.88 | 258.80 | 267.78 |
| 1 3/8 | 205.68 | 215.04 | 224.40 | 233.76 | 243.08 | 252.44 | 261.80 | 271.16 | 280.48 |
| 1 7/16 | 215.04 | 224.84 | 234.60 | 244.40 | 254.16 | 263.92 | 273.68 | 283.52 | 293.28 |
| 1 1/2 | 224.40 | 234.60 | 244.80 | 255.00 | 265.20 | 275.44 | 285.60 | 295.84 | 306.04 |
| 1 9/16 | 233.75 | 244.38 | 255.00 | 265.63 | 276.25 | 286.88 | 297.50 | 308.13 | 318.75 |
| 1 5/8 | 243.10 | 254.15 | 265.20 | 276.25 | 287.30 | 298.35 | 309.40 | 320.45 | 331.50 |
| 1 11/16 | 252.45 | 263.93 | 275.40 | 286.88 | 298.35 | 309.83 | 321.30 | 332.78 | 344.25 |
| 1 3/4 | 261.80 | 273.70 | 285.60 | 297.50 | 309.40 | 321.30 | 333.20 | 345.10 | 357.00 |
| 1 13/16 | 271.15 | 283.48 | 295.80 | 308.13 | 320.45 | 332.78 | 345.10 | 357.43 | 369.75 |
| 1 7/8 | 280.50 | 293.25 | 306.00 | 318.75 | 331.50 | 344.25 | 357.00 | 369.75 | 382.50 |
| 1 15/16 | 289.85 | 303.03 | 316.20 | 329.38 | 342.55 | 355.73 | 368.90 | 382.08 | 395.25 |
| 2 | 299.20 | 312.80 | 326.40 | 340.00 | 353.60 | 367.20 | 380.80 | 394.40 | 408.00 |

# Universal Mill Plates

## Sizes, with Maximum Lengths in Feet

| Thickness, Inches | Width, Inches | | | | |
|---|---|---|---|---|---|
| | 14-17 Inclusive | 18-21 Inclusive | 22 | 23 | 24-36 Inclusive |
| 1/4 | 85 | 85 | 85 | 85 | 85 |
| 5/16 | 85 | 85 | 85 | 85 | 85 |
| 3/8 | 85 | 85 | 85 | 85 | 85 |
| 7/16 | 85 | 85 | 85 | 85 | 85 |
| 1/2 | 85 | 85 | 85 | 85 | 85 |
| 9/16 | 85 | 85 | 85 | 85 | 85 |
| 5/8 | 85 | 85 | 85 | 85 | 85 |
| 11/16 | 85 | 85 | 85 | 85 | 85 |
| 3/4 | 85 | 85 | 85 | 85 | 85 |
| 13/16 | 85 | 85 | 85 | 85 | 85 |
| 7/8 | 85 | 85 | 85 | 85 | 85 |
| 15/16 | 85 | 85 | 85 | 85 | 85 |
| 1 | 85 | 85 | 85 | 85 | 83 |
| 1 1/8 | 85 | 85 | 85 | 85 | 78 |
| 1 1/4 | 85 | 85 | 85 | 85 | 70 |
| 1 3/8 | 85 | 85 | 83 | 78 | 64 |
| 1 1/2 | 80 | 80 | 76 | 71 | 58 |
| 1 5/8 | 73 | 73 | 70 | 68 | 53 |
| 1 3/4 | 68 | 68 | 65 | 61 | 48 |
| 1 7/8 | 64 | 64 | 61 | 56 | 46 |
| 2 | 60 | 60 | 56 | 53 | 43 |

For intermediate widths not shown in above table, use length of next greater width.

# Sheared Plates

## Lengths of Rectangular Plates Rolled on 108-inch Mill

| Thickness, Inches | Width, Inches | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 102 | 98 | 94 | 90 | 88 | 84 | 80 | 76 | 72 | 68 |
| ¼ | .... | .... | .... | 192 | 192 | 216 | 228 | 240 | 252 | 264 |
| $\frac{5}{16}$ | .... | 192 | 240 | 252 | 264 | 264 | 276 | 282 | 300 | 340 |
| ⅜ | 180 | 192 | 240 | 252 | 264 | 300 | 360 | 360 | 360 | 360 |
| $\frac{7}{16}$ | 180 | 192 | 240 | 252 | 264 | 300 | 360 | 360 | 360 | 360 |
| ½ | 180 | 216 | 240 | 276 | 300 | 300 | 360 | 360 | 360 | 360 |
| $\frac{9}{16}$ | 180 | 216 | 240 | 276 | 300 | 360 | 360 | 360 | 360 | 360 |
| ⅝ | 180 | 216 | 240 | 276 | 300 | 360 | 360 | 360 | 360 | 360 |
| $\frac{11}{16}$ | 180 | 216 | 240 | 276 | 300 | 360 | 360 | 360 | 360 | 360 |
| ¾ | 180 | 216 | 240 | 252 | 300 | 360 | 360 | 360 | 360 | 360 |
| $\frac{13}{16}$ | 180 | 216 | 240 | 252 | 300 | 300 | 336 | 340 | 360 | 360 |
| ⅞ | 180 | 216 | 240 | 240 | 300 | 300 | 336 | 340 | 360 | 360 |
| 1 | 180 | 216 | 240 | 240 | 300 | 300 | 300 | 324 | 360 | 360 |
| 1¼ | 156 | 180 | 192 | 216 | 276 | 276 | 276 | 276 | 300 | 300 |
| 1⅜ | 132 | 132 | 180 | 192 | 240 | 240 | 252 | 252 | 252 | 276 |
| 1½ | 132 | 132 | 180 | 192 | 240 | 240 | 192 | 192 | 192 | 240 |
| 1⅝ | 120 | 120 | 120 | 132 | 132 | 192 | 192 | 192 | 192 | 192 |
| 1¾ | 108 | 108 | 108 | 120 | 120 | 180 | 180 | 180 | 180 | 180 |
| 1⅞ | .... | .... | 108 | 120 | 120 | 144 | 144 | 144 | 144 | 144 |
| 2 | .... | .... | 96 | 108 | 120 | 120 | 126 | 132 | 144 | 144 |
| 2¼ | .... | .... | 96 | 108 | 120 | 126 | 132 | 132 | 144 | 144 |
| 2½ | .... | .... | 96 | 108 | 120 | 126 | 132 | 132 | 144 | 144 |

Plates of greater dimensions than shown in this table may be submitted for special consideration.

# Sheared Plates

## Lengths of Rectangular Plates Rolled on 108-inch Mill

**Continued**

| Thickness, Inches | Width, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 64 | 60 | 56 | 52 | 48 | 44 | 40 | 36 | 24 |
| ¼ | 288 | 300 | 300 | 312 | 336 | 360 | 360 | 360 | 36 |
| $\frac{5}{16}$ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| ⅜ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| $\frac{7}{16}$ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| ½ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| $\frac{9}{16}$ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| ⅝ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| $\frac{11}{16}$ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| ¾ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| $\frac{13}{16}$ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| ⅞ | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| 1 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 360 | 36 |
| 1¼ | 300 | 300 | 300 | 300 | 360 | 360 | 360 | 360 | 30 |
| 1⅜ | 276 | 276 | 276 | 300 | 300 | 300 | 300 | 360 | 30 |
| 1½ | 240 | 252 | 252 | 252 | 276 | 300 | 300 | 300 | 27 |
| 1⅝ | 216 | 240 | 252 | 252 | 276 | 276 | 276 | 300 | 27 |
| 1¾ | 192 | 192 | 240 | 240 | 252 | 252 | 252 | 276 | 25 |
| 1⅞ | 156 | 180 | 192 | 192 | 240 | 240 | 240 | 252 | 24 |
| 2 | 156 | 180 | 180 | 180 | 192 | 192 | 192 | 240 | 24 |
| 2¼ | 156 | 180 | 180 | 180 | 180 | 180 | 180 | 144 | 14 |
| 2½ | 156 | 156 | 156 | 180 | 180 | 180 | 180 | 144 | 14 |

Plates of greater dimensions than shown in this table may be submitted f
special consideration.

# Sheared Plates

## Lengths of Rectangular Plates Rolled on 78-inch Mill

| Thickness, With Decimal Equivalent | Width, Inches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 72 | 70 | 68 | 66 | 65 | 60 | 56 | 52 |
| *No. 11 Gauge... .125" | ..... | ..... | ..... | ..... | ..... | 144 | 168 | 180 |
| †No. 10 Gauge... .134" | ..... | ..... | ..... | 120 | 132 | 168 | 180 | 192 |
| †No. 9 Gauge... .148" | ..... | ..... | ..... | 120 | 144 | 168 | 180 | 192 |
| †No. 8 Gauge... .165" | ..... | ..... | 120 | 144 | 156 | 168 | 180 | 192 |
| 3/16-inch.......... .187" | 132 | 144 | 156 | 168 | 180 | 192 | 204 | 216 |
| 7/32 and 1/4-inch.... .219" .250" | 120 | 120 | 132 | 144 | 180 | 192 | 204 | 216 |
| 5/16-inch.......... .313" | ..... | ..... | ..... | ..... | 108 | 144 | 156 | 168 |
| 3/8-inch.......... .375" | ..... | ..... | ..... | ..... | 96 | 120 | 144 | 156 |

| Thickness, With Decimal Equivalent | Width, Inches | | | | | | |
|---|---|---|---|---|---|---|---|
| | 48 | 44 | 40 | 36 | 32 | 28 | 24 |
| *No. 11 Gauge........ .125" | 192 | 204 | 216 | 228 | 240 | 252 | 264 |
| †No. 10 Gauge........ .134" | 204 | 216 | 228 | 240 | 252 | 264 | 276 |
| †No. 9 Gauge........ .148" | 204 | 216 | 228 | 240 | 252 | 264 | 276 |
| †No. 8 Gauge........ .165" | 216 | 228 | 240 | 252 | 264 | 276 | 288 |
| 3/16-inch.............. .187" | 228 | 240 | 264 | 288 | 300 | 300 | 300 |
| 7/32 and 1/4-inch........ .219" .250" | 228 | 240 | 252 | 264 | 276 | 288 | 300 |
| 5/16-inch.............. .313" | 180 | 192 | 204 | 216 | 264 | 300 | 300 |
| 3/8-inch.............. .375" | 180 | 192 | 216 | 240 | 252 | 264 | 276 |

*U. S. Standard.

†Birmingham.

*Plates of greater dimensions* than shown in this table may be submitted for *special consideration.*

*All our plates are accurately* straightened by the most improved methods.

## Sketch Plates

Sketch plates, as known in the trade, are sheared plates having other than a rectangular outline. This is modified, in practice, to except straight taper plates varying not more than four inches in width at the ends and having a width at the narrowest end of not less than thirty inches.

It is also customary to except complete circles, circular plates being classified by themselves.

## Dimensions of Circular Plates

| Thickness, Inches | Maximum Diameter, Inches | Thickness, Inches | Maximum Diameter, Inches |
|---|---|---|---|
| 1/8 | 65 | 9/16 | 103 |
| 3/16 | 72 | 5/8 | 103 |
| 1/4 | 90 | 11/16 | 103 |
| 5/16 | 100 | 3/4 up to 1 1/2 | 103 |
| 3/8 | 103 | | |
| 7/16 | 103 | | |
| 1/2 | 103 | | |

# Weights of Circular Plates

| Diameter, Inches | Thickness Inches | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 |
| 16 | 7 | 11 | 14 | 18 | 21 | 25 | 28 | 32 | 36 | 39 | 42 |
| 17 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |
| 18 | 9 | 14 | 18 | 23 | 27 | 32 | 36 | 41 | 46 | 50 | 54 |
| 19 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| 20 | 11 | 17 | 22 | 28 | 33 | 39 | 45 | 50 | 56 | 61 | 67 |
| 21 | 12 | 19 | 25 | 31 | 37 | 43 | 50 | 55 | 61 | 68 | 74 |
| 22 | 14 | 20 | 27 | 34 | 40 | 47 | 54 | 61 | 67 | 74 | 81 |
| 23 | 15 | 22 | 30 | 37 | 44 | 52 | 59 | 66 | 74 | 81 | 88 |
| 24 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 |
| 25 | 18 | 26 | 35 | 44 | 52 | 61 | 70 | 78 | 87 | 96 | 104 |
| 26 | 19 | 28 | 38 | 47 | 57 | 66 | 75 | 85 | 94 | 103 | 113 |
| 27 | 20 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 112 | 122 |
| 28 | 22 | 33 | 44 | 55 | 66 | 76 | 87 | 98 | 109 | 120 | 131 |
| 29 | 24 | 35 | 47 | 59 | 70 | 82 | 94 | 105 | 117 | 129 | 140 |
| 30 | 25 | 38 | 50 | 63 | 75 | 88 | 100 | 113 | 125 | 138 | 150 |
| 31 | 27 | 40 | 54 | 67 | 80 | 94 | 107 | 120 | 134 | 147 | 160 |
| 32 | 29 | 43 | 57 | 71 | 86 | 100 | 114 | 128 | 142 | 157 | 171 |
| 33 | 31 | 46 | 61 | 76 | 91 | 106 | 121 | 136 | 152 | 167 | 182 |
| 34 | 32 | 48 | 64 | 81 | 97 | 113 | 129 | 145 | 161 | 177 | 193 |
| 35 | 34 | 51 | 68 | 85 | 102 | 119 | 136 | 153 | 170 | 187 | 204 |
| 36 | 36 | 54 | 72 | 90 | 108 | 126 | 144 | 162 | 180 | 198 | 216 |
| 37 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 | 190 | 210 | 229 |
| 38 | 40 | 60 | 80 | 100 | 121 | 141 | 161 | 181 | 201 | 221 | 241 |
| 39 | 42 | 64 | 85 | 106 | 127 | 148 | 169 | 190 | 212 | 233 | 254 |
| 40 | 45 | 67 | 89 | 111 | 134 | 156 | 178 | 200 | 223 | 245 | 267 |

# Weights of Circular Plates
Continued

| Diameter, Inches | Thickness, Inches | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 |
| 41 | 47 | 70 | 94 | 117 | 140 | 164 | 187 | 210 | 234 | 257 | 281 |
| 42 | 49 | 74 | 98 | 123 | 147 | 172 | 196 | 221 | 245 | 270 | 294 |
| 43 | 52 | 77 | 103 | 129 | 154 | 180 | 206 | 232 | 257 | 283 | 309 |
| 44 | 54 | 81 | 108 | 135 | 162 | 189 | 215 | 242 | 269 | 296 | 323 |
| 45 | 56 | 85 | 113 | 141 | 169 | 197 | 225 | 254 | 282 | 310 | 338 |
| 46 | 59 | 88 | 118 | 147 | 167 | 206 | 236 | 265 | 294 | 324 | 353 |
| 47 | 62 | 92 | 123 | 154 | 184 | 215 | 246 | 277 | 307 | 338 | 369 |
| 48 | 64 | 96 | 128 | 160 | 192 | 224 | 256 | 288 | 320 | 353 | 385 |
| 49 | 67 | 100 | 134 | 167 | 200 | 234 | 267 | 301 | 334 | 367 | 401 |
| 50 | 70 | 104 | 139 | 174 | 209 | 243 | 278 | 313 | 348 | 383 | 417 |
| 51 | 73 | 109 | 145 | 181 | 217 | 253 | 289 | 326 | 362 | 398 | 434 |
| 52 | 75 | 113 | 150 | 188 | 226 | 263 | 301 | 339 | 376 | 414 | 451 |
| 53 | 78 | 117 | 156 | 195 | 234 | 274 | 313 | 352 | 391 | 430 | 469 |
| 54 | 81 | 122 | 162 | 203 | 243 | 284 | 325 | 365 | 406 | 446 | 487 |
| 55 | 84 | 126 | 168 | 210 | 252 | 295 | 337 | 379 | 421 | 463 | 505 |
| 56 | 88 | 131 | 175 | 218 | 262 | 305 | 349 | 393 | 436 | 480 | 524 |
| 57 | 91 | 136 | 181 | 226 | 271 | 317 | 362 | 407 | 452 | 497 | 542 |
| 58 | 94 | 141 | 187 | 234 | 281 | 328 | 375 | 421 | 468 | 515 | 562 |
| 59 | 97 | 145 | 194 | 242 | 291 | 339 | 388 | 436 | 484 | 533 | 581 |
| 60 | 101 | 150 | 201 | 251 | 301 | 351 | 401 | 451 | 501 | 551 | 601 |
| 61 | 104 | 155 | 207 | 259 | 311 | 363 | 414 | 466 | 518 | 570 | 621 |
| 62 | 107 | 160 | 214 | 268 | 321 | 375 | 428 | 482 | 535 | 588 | 642 |
| 63 | 111 | 166 | 221 | 276 | 332 | 387 | 442 | 497 | 552 | 608 | 663 |
| 64 | 114 | 171 | 228 | 285 | 342 | 399 | 456 | 513 | 570 | 627 | 684 |
| 65 | 118 | 176 | 235 | 294 | 353 | 412 | 470 | 529 | 588 | 647 | 705 |

# Weights of Circular Plates

| Diameter, Inches | Thickness Inches | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 |
| 16 | 7 | 11 | 14 | 18 | 21 | 25 | 28 | 32 | 36 | 39 | 42 |
| 17 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |
| 18 | 9 | 14 | 18 | 23 | 27 | 32 | 36 | 41 | 46 | 50 | 54 |
| 19 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| 20 | 11 | 17 | 22 | 28 | 33 | 39 | 45 | 50 | 56 | 61 | 67 |
| 21 | 12 | 19 | 25 | 31 | 37 | 43 | 50 | 55 | 61 | 68 | 74 |
| 22 | 14 | 20 | 27 | 34 | 40 | 47 | 54 | 61 | 67 | 74 | 81 |
| 23 | 15 | 22 | 30 | 37 | 44 | 52 | 59 | 66 | 74 | 81 | 88 |
| 24 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 |
| 25 | 18 | 26 | 35 | 44 | 52 | 61 | 70 | 78 | 87 | 96 | 104 |
| 26 | 19 | 28 | 38 | 47 | 57 | 66 | 75 | 85 | 94 | 103 | 113 |
| 27 | 20 | 31 | 41 | 51 | 61 | 71 | 81 | 91 | 101 | 112 | 122 |
| 28 | 22 | 33 | 44 | 55 | 66 | 76 | 87 | 98 | 109 | 120 | 131 |
| 29 | 24 | 35 | 47 | 59 | 70 | 82 | 94 | 105 | 117 | 129 | 140 |
| 30 | 25 | 38 | 50 | 63 | 75 | 88 | 100 | 113 | 125 | 138 | 150 |
| 31 | 27 | 40 | 54 | 67 | 80 | 94 | 107 | 120 | 134 | 147 | 160 |
| 32 | 29 | 43 | 57 | 71 | 86 | 100 | 114 | 128 | 142 | 157 | 171 |
| 33 | 31 | 46 | 61 | 76 | 91 | 106 | 121 | 136 | 152 | 167 | 182 |
| 34 | 32 | 48 | 64 | 81 | 97 | 113 | 129 | 145 | 161 | 177 | 193 |
| 35 | 34 | 51 | 68 | 85 | 102 | 119 | 136 | 153 | 170 | 187 | 204 |
| 36 | 36 | 54 | 72 | 90 | 108 | 126 | 144 | 162 | 180 | 198 | 216 |
| 37 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 | 190 | 210 | 229 |
| 38 | 40 | 60 | 80 | 100 | 121 | 141 | 161 | 181 | 201 | 221 | 241 |
| 39 | 42 | 64 | 85 | 106 | 127 | 148 | 169 | 190 | 212 | 233 | 254 |
| 40 | 45 | 67 | 89 | 111 | 134 | 156 | 178 | 200 | 223 | 245 | 267 |

# Weights of Circular Plates
Continued

| Diameter, Inches | Thickness, Inches | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 |
| 41 | 47 | 70 | 94 | 117 | 140 | 164 | 187 | 210 | 234 | 257 | 281 |
| 42 | 49 | 74 | 98 | 123 | 147 | 172 | 196 | 221 | 245 | 270 | 294 |
| 43 | 52 | 77 | 103 | 129 | 154 | 180 | 206 | 232 | 257 | 283 | 309 |
| 44 | 54 | 81 | 108 | 135 | 162 | 189 | 215 | 242 | 269 | 296 | 323 |
| 45 | 56 | 85 | 113 | 141 | 169 | 197 | 225 | 254 | 282 | 310 | 338 |
| 46 | 59 | 88 | 118 | 147 | 167 | 206 | 236 | 265 | 294 | 324 | 353 |
| 47 | 62 | 92 | 123 | 154 | 184 | 215 | 246 | 277 | 307 | 338 | 369 |
| 48 | 64 | 96 | 128 | 160 | 192 | 224 | 256 | 288 | 320 | 353 | 385 |
| 49 | 67 | 100 | 134 | 167 | 200 | 234 | 267 | 301 | 334 | 367 | 401 |
| 50 | 70 | 104 | 139 | 174 | 209 | 243 | 278 | 313 | 348 | 383 | 417 |
| 51 | 73 | 109 | 145 | 181 | 217 | 253 | 289 | 326 | 362 | 398 | 434 |
| 52 | 75 | 113 | 150 | 188 | 226 | 263 | 301 | 339 | 376 | 414 | 451 |
| 53 | 78 | 117 | 156 | 195 | 234 | 274 | 313 | 352 | 391 | 430 | 469 |
| 54 | 81 | 122 | 162 | 203 | 243 | 284 | 325 | 365 | 406 | 446 | 487 |
| 55 | 84 | 126 | 168 | 210 | 252 | 295 | 337 | 379 | 421 | 463 | 505 |
| 56 | 88 | 131 | 175 | 218 | 262 | 305 | 349 | 393 | 436 | 480 | 524 |
| 57 | 91 | 136 | 181 | 226 | 271 | 317 | 362 | 407 | 452 | 497 | 542 |
| 58 | 94 | 141 | 187 | 234 | 281 | 328 | 375 | 421 | 468 | 515 | 562 |
| 59 | 97 | 145 | 194 | 242 | 291 | 339 | 388 | 436 | 484 | 533 | 581 |
| 60 | 101 | 150 | 201 | 251 | 301 | 351 | 401 | 451 | 501 | 551 | 601 |
| 61 | 104 | 155 | 207 | 259 | 311 | 363 | 414 | 466 | 518 | 570 | 621 |
| 62 | 107 | 160 | 214 | 268 | 321 | 375 | 428 | 482 | 535 | 588 | 642 |
| 63 | 111 | 166 | 221 | 276 | 332 | 387 | 442 | 497 | 552 | 608 | 663 |
| 64 | 114 | 171 | 228 | 285 | 342 | 399 | 456 | 513 | 570 | 627 | 684 |
| 65 | 118 | 176 | 235 | 294 | 353 | 412 | 470 | 529 | 588 | 647 | 705 |

## Weights of Circular Plates

**Continued**

| Diameter, Inches | Thickness, Inches | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 |
| 66 | 243 | 303 | 364 | 424 | 485 | 546 | 606 | 667 | 727 | 757 | 848 | 909 | 970 |
| 67 | 250 | 312 | 375 | 437 | 500 | 562 | 625 | 687 | 750 | 812 | 874 | 937 | 1000 |
| 68 | 258 | 322 | 386 | 450 | 515 | 579 | 643 | 708 | 772 | 786 | 900 | 965 | 1030 |
| 69 | 265 | 331 | 398 | 464 | 530 | 596 | 662 | 729 | 795 | 866 | 928 | 994 | 1060 |
| 70 | 273 | 341 | 409 | 477 | 546 | 614 | 682 | 750 | 818 | 886 | 954 | 1023 | 1092 |
| 71 | 281 | 351 | 421 | 491 | 561 | 631 | 702 | 772 | 842 | 912 | 982 | 1052 | 1122 |
| 72 | 289 | 361 | 433 | 505 | 577 | 649 | 721 | 794 | 866 | 938 | 1010 | 1082 | 1154 |
| 73 | 297 | 371 | 445 | 519 | 593 | 667 | 741 | 816 | 890 | 964 | 1038 | 1112 | 1186 |
| 74 | 305 | 381 | 457 | 533 | 610 | 686 | 762 | 838 | 914 | 990 | 1066 | 1143 | 1220 |
| 75 | 313 | 391 | 470 | 548 | 626 | 705 | 783 | 861 | 939 | 1018 | 1096 | 1172 | 1252 |
| 76 | 322 | 402 | 482 | 563 | 643 | 723 | 804 | 884 | 964 | 1045 | 1125 | 1205 | 1286 |
| 77 | 330 | 413 | 495 | 578 | 660 | 743 | 825 | 907 | 990 | 1072 | 1155 | 1237 | 1320 |
| 78 | 339 | 423 | 508 | 593 | 677 | 762 | 847 | 931 | 1016 | 1100 | 1185 | 1270 | 1354 |
| 79 | 348 | 434 | 521 | 608 | 695 | 782 | 868 | 955 | 1042 | 1129 | 1216 | 1302 | 1389 |
| 80 | 356 | 445 | 534 | 623 | 712 | 802 | 891 | 980 | 1069 | 1158 | 1247 | 1336 | 1425 |
| 81 | 365 | 457 | 548 | 639 | 730 | 822 | 913 | 1004 | 1095 | 1187 | 1278 | 1369 | 1460 |
| 82 | 374 | 468 | 561 | 655 | 748 | 842 | 936 | 1029 | 1123 | 1216 | 1310 | 1403 | 1497 |
| 83 | 384 | 479 | 575 | 671 | 767 | 863 | 960 | 1054 | 1150 | 1246 | 1342 | 1438 | 1533 |
| 84 | 393 | 491 | 589 | 687 | 785 | 884 | 982 | 1080 | 1178 | 1276 | 1374 | 1472 | 1571 |
| 85 | 402 | 503 | 603 | 704 | 804 | 905 | 1005 | 1106 | 1206 | 1307 | 1407 | 1509 | 1608 |
| 86 | 412 | 515 | 618 | 720 | 823 | 926 | 1029 | 1132 | 1235 | 1338 | 1441 | 1543 | 1646 |
| 87 | 421 | 527 | 632 | 737 | 843 | 948 | 1053 | 1158 | 1264 | 1369 | 1474 | 1580 | 1685 |
| 88 | 431 | 539 | 647 | 754 | 862 | 970 | 1077 | 1185 | 1293 | 1400 | 1508 | 1616 | 1724 |
| 89 | 441 | 551 | 662 | 772 | 882 | 992 | 1102 | 1212 | 1323 | 1433 | 1543 | 1653 | 1763 |
| 90 | 451 | 564 | 676 | 789 | 902 | 1014 | 1127 | 1240 | 1352 | 1465 | 1577 | 1690 | 1803 |

# Weights of Circular Plates

**Continued**

| Diameter, Inches | Thickness, Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 |
| 91 | 576 | 691 | 807 | 922 | 1037 | 1152 | 1267 | 1382 | 1498 | 1613 | 1728 | 1843 |
| 92 | 589 | 707 | 824 | 942 | 1060 | 1178 | 1295 | 1413 | 1531 | 1648 | 1766 | 1884 |
| 93 | 602 | 722 | 842 | 963 | 1083 | 1203 | 1324 | 1444 | 1564 | 1684 | 1805 | 1925 |
| 94 | 615 | 738 | 861 | 984 | 1106 | 1224 | 1352 | 1475 | 1598 | 1721 | 1844 | 1967 |
| 95 | 628 | 754 | 879 | 1005 | 1130 | 1256 | 1381 | 1507 | 1632 | 1758 | 1883 | 2009 |
| 96 | 641 | 769 | 897 | 1025 | 1154 | 1282 | 1410 | 1538 | 1666 | 1795 | 1923 | 2051 |
| 97 | 654 | 785 | 916 | 1047 | 1178 | 1309 | 1440 | 1570 | 1701 | 1832 | 1963 | 2094 |
| 98 | 668 | 801 | 935 | 1069 | 1202 | 1336 | 1469 | 1603 | 1737 | 1870 | 2004 | 2137 |
| 99 | 682 | 818 | 954 | 1091 | 1227 | 1363 | 1500 | 1636 | 1772 | 1908 | 2045 | 2181 |
| 100 | 695 | 835 | 974 | 1113 | 1252 | 1391 | 1530 | 1669 | 1808 | 1947 | 2086 | 2225 |
| 101 | 709 | 851 | 993 | 1135 | 1277 | 1419 | 1561 | 1703 | 1844 | 1986 | 2128 | 2270 |
| 102 | 724 | 868 | 1013 | 1158 | 1302 | 1447 | 1592 | 1736 | 1881 | 2026 | 2171 | 2315 |
| 103 | 738 | 885 | 1033 | 1180 | 1328 | 1476 | 1623 | 1771 | 1918 | 2066 | 2213 | 2361 |
| 104 | 752 | 903 | 1053 | 1203 | 1354 | 1504 | 1655 | 1805 | 1956 | 2106 | 2257 | 2407 |
| 105 | 767 | 920 | 1073 | 1227 | 1380 | 1533 | 1687 | 1840 | 1993 | 2147 | 2300 | 2453 |
| 106 | 781 | 938 | 1094 | 1250 | 1407 | 1563 | 1719 | 1875 | 2032 | 2188 | 2344 | 2500 |
| 107 | 796 | 955 | 1115 | 1274 | 1433 | 1592 | 1752 | 1911 | 2070 | 2229 | 2389 | 2548 |
| 108 | 811 | 973 | 1136 | 1298 | 1460 | 1622 | 1785 | 1947 | 2109 | 2271 | 2433 | 2596 |
| 109 | 826 | 992 | 1157 | 1322 | 1487 | 1652 | 1818 | 1983 | 2148 | 2313 | 2479 | 2644 |
| 110 | 841 | 1010 | 1178 | 1346 | 1515 | 1683 | 1851 | 2020 | 2188 | 2356 | 2524 | 2693 |
| 111 | 857 | 1028 | 1200 | 1371 | 1542 | 1714 | 1885 | 2056 | 2228 | 2400 | 2570 | 2742 |
| 112 | 872 | 1047 | 1221 | 1396 | 1570 | 1745 | 1919 | 2094 | 2268 | 2443 | 2617 | 2791 |
| 113 | 888 | 1065 | 1243 | 1420 | 1598 | 1776 | 1953 | 2131 | 2308 | 2486 | 2663 | 2841 |
| 114 | 904 | 1085 | 1266 | 1446 | 1627 | 1808 | 1989 | 2170 | 2350 | 2531 | 2712 | 2893 |
| 115 | 920 | 1104 | 1288 | 1471 | 1656 | 1839 | 2024 | 2208 | 2392 | 2575 | 2759 | 2943 |

Our limit for rolling is 103" diameter (100" for 5/16" thickness). Larger sizes are for reference only. Plates up to 1 1/2" thick are rolled. To obtain weights add weight of fractional thickness to that given above for 1" thickness.

# Bars for Concrete Reinforcement

## Cold Twisted Square Bar

| Size, Inches | Area, Square Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|
| 1/4 | .0625 | .212 | 40 |
| 5/16 | .0977 | .332 | 40 |
| 3/8 | .1406 | .478 | 40 |
| 7/16 | .1914 | .651 | 40 |
| 1/2 | .2500 | .850 | 40 |
| 9/16 | .3164 | 1.076 | 40 |
| 5/8 | .3906 | 1.328 | 40 |
| 11/16 | .4727 | 1.607 | 40 |
| 3/4 | .5625 | 1.913 | 60 |
| 13/16 | .6602 | 2.245 | 60 |
| 7/8 | .7656 | 2.603 | 60 |
| 15/16 | .8789 | 2.988 | 60 |
| 1 | 1.0000 | 3.400 | 60 |
| 1 1/8 | 1.2656 | 4.303 | 60 |
| 1 1/4 | 1.5625 | 5.312 | 60 |
| 1 3/8 | 1.8906 | 6.428 | 60 |
| 1 1/2 | 2.2500 | 7.650 | 60 |

Unless otherwise specified, cold twisted bars are made from low carbon Steel, and after twisting have an elastic limit ranging from 55,000 pounds per square inch for 1 1/2" bars to 75,000 pounds per square inch for 1/4" bars.

All intermediate sizes can be furnished.

Weights and Areas of Twisted Bars are equal to plain square bars of like *denominations.*

*Longer lengths furnished only* by special arrangement.

*Circular mailed upon application.*

# Bars for Concrete Reinforcement

## Diamond Bar

| Size, Inches | Area, Square Inches | Weight per Foot, Pounds | Maximum Length, Feet |
|---|---|---|---|
| 3/8 | .1406 | .478 | 40 |
| 7/16 | .1914 | .651 | 40 |
| 1/2 | .2500 | .850 | 40 |
| 5/8 | .3906 | 1.328 | 40 |
| 3/4 | .5625 | 1.913 | 60 |
| 7/8 | .7656 | 2.603 | 60 |
| 1 | 1.0000 | 3.400 | 60 |
| 1 1/8 | 1.2656 | 4.303 | 60 |
| 1 1/4 | 1.5625 | 5.312 | 60 |
| 1 1/2 | 2.2500 | 7.650 | 60 |

Weights and areas of Diamond Bars are equal to plain Square Bars of like denominations.

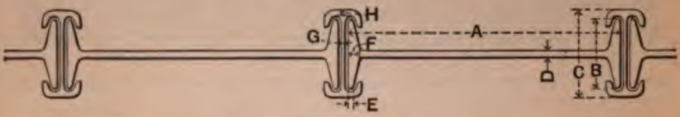
Longer lengths furnished only by special arrangement.

Circular mailed upon application.

# J & L Sheet Piling

**Under Patent Dated October 13, 1908**

## Weights and Dimensions




| Section Index | Size, Inches | Weight Per Sq. Ft., Pounds | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|---|---|
| 000 | 12 x 4¼ | 32.00 | 12 | 2.90 | 4¼ | 0.335 | 0.35 | 0.75 | 0.21 | 0.56 |
| 00 | 12 x 4¼ | 33.50 | 12 | 2.94 | 4¼ | 0.375 | 0.35 | 0.75 | 0.21 | 0.56 |
| 0 | 12 x 4¼ | 35.00 | 12 | 2.94 | 4¼ | 0.415 | 0.35 | 0.75 | 0.21 | 0.56 |
| 1 | 12 x 5 | 35.00 | 12 | 3.94 | 5 | 0.34 | 0.35 | 0.65 | 0.21 | 0.44 |
| 2 | 12 x 5 | 36.25 | 12 | 3.94 | 5 | 0.38 | 0.35 | 0.65 | 0.21 | 0.44 |
| 3 | 15 x 6 | 37.20 | 15 | 4.75 | 6 | 0.38 | 0.37 | 0.74 | 0.23 | 0.49 |
| 4 | 15 x 6 | 39.75 | 15 | 4.75 | 6 | 0.44 | 0.37 | 0.74 | 0.23 | 0.49 |
| 5 | 15 x 6 | 42.25 | 15 | 4.75 | 6 | 0.50 | 0.37 | 0.74 | 0.23 | 0.49 |

From the above table and cuts and those on following pages, it will be seen that J & L SHEET PILING has been designed from an economical and efficient basis. There are eight sections available, embracing economy in weight, high section modulus, free driving qualities, etc.

The metal is so distributed as to form a rigid section, which means efficiency inasmuch as the blows from the hammer are all effective and the energy is not lost in overcoming excessive friction and distortion.

The joints are practically watertight as driven, which is important, especially in cofferdam work or in "cut-off" walls.

We attach a locking bar to one flange of each piling beam at the mill before shipment and these are shipped, handled and driven as a unit.

The piling beams have a maximum salvage value, as, when no longer required as piling, the sections (being 12″ and 15″ beams) are available for other uses.

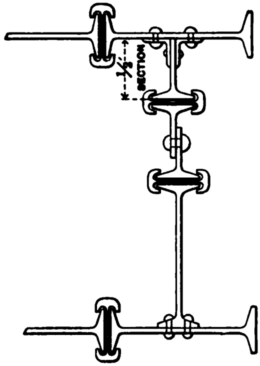
For information regarding the strength of the interlock see page 86.

Illustrated Catalogue mailed upon application.

# J & L Sheet Piling

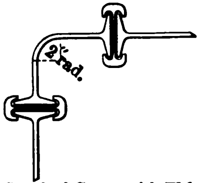
## Standard Corner Pieces and Special Connections

Special Fabricated Corner and Connection. ½ Section attached to Web of Another Section by Means of Angles and Rivets.

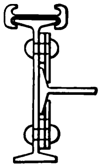



Section Employed to Straighten Wall when Toe of Section has been Thrown Forward or Back from a Vertical Line.

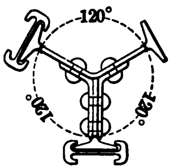
Special Corner and Connection. Flange of One I-Beam Riveted Direct to Web of Another Section.



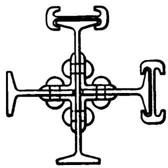

Standard Corner with Web Bent 90° with a 2 inch Radius



Special Section for Cross Wall Connection




120° Y Pile



90° Cross

The above are corner pieces and special connections which are ordinarily usec but if unusual conditions or special designs require other details, this piling ca readily be adapted to meet such situations.

# J & L Sheet Piling

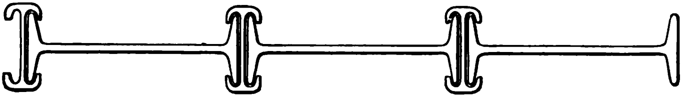
## Properties of Sheet Piling Beams

| Section Index | Depth of Beam, Inches | Weight per Linear Foot, Pounds | Area of Section, Square Inches | Thickness of Web, Inches | Width of Flange, Inches | Moment of Inertia Neutral Axis Perpendicular to Web at Center | Moment of Inertia Neutral Axis Coincident with Center Line of Web | Radius of Gyration Neutral Axis Perpendicular to Web at Center | Radius of Gyration Neutral Axis Coincident with Center Line of Web | Section Factor Neutral Axis Perpendicular to Web at Center | Section Factor Neutral Axis Coincident with Center Line of Web |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-315 | 12 | 23.26 | 6.84 | 0.34 | 2.90 | 140.50 | 1.92 | 4.53 | 0.53 | 23.42 | 1.32 |
| B-314 | 12 | 24.90 | 7.32 | 0.38 | 2.94 | 146.27 | 2.01 | 4.47 | 0.52 | 24.38 | 1.37 |
| B-313 | 12 | 26.37 | 7.76 | 0.42 | 2.94 | 150.47 | 2.04 | 4.40 | 0.51 | 25.08 | 1.38 |
| B-310 | 12 | 26.30 | 7.72 | 0.34 | 3.94 | 167.76 | 4.43 | 4.67 | 0.76 | 27.96 | 2.25 |
| B-309 | 12 | 27.60 | 8.10 | 0.38 | 3.94 | 172.10 | 4.56 | 4.61 | 0.75 | 28.68 | 2.30 |
| B-302 | 15 | 35.75 | 10.50 | 0.38 | 4.75 | 358.16 | 8.52 | 5.84 | 0.90 | 47.75 | 3.59 |
| B-301 | 15 | 39.00 | 11.44 | 0.44 | 4.75 | 375.03 | 8.91 | 5.71 | 0.88 | 50.00 | 3.70 |
| B-300 | 15 | 42.25 | 12.37 | 0.50 | 4.75 | 391.92 | 9.31 | 5.62 | 0.87 | 52.25 | 3.82 |

## Properties of Locking Bars

| Section Index | Depth of Locking Bar, Inches | Weight per Linear Foot, Pounds | Area of Sections, Square Inches | Thickness of Web, Inches | Moment of Inertia Neutral Axis Perpendicular to Web at Center | Moment of Inertia Neutral Axis Coincident with Center Line of Web | Radius of Gyration Neutral Axis Perpendicular to Web at Center | Radius of Gyration Neutral Axis Coincident with Center Line of Web | Section Factor Neutral Axis Perpendicular to Web at Center | Section Factor Neutral Axis Coincident with Center Line of Web |
|---|---|---|---|---|---|---|---|---|---|---|
| B-322 | 4¼ | 10.3 | 3.00 | 0.21 | 7.50 | 0.87 | 1.58 | 0.54 | 3.53 | 0.54 |
| B-321 | 5 | 9.75 | 2.87 | 0.21 | 10.50 | 0.64 | 1.91 | 0.47 | 4.20 | 0.64 |
| *B-316* | *6* | *12.25* | *3.61* | *0.23* | 18.42 | 1.11 | 2.26 | 0.55 | 6.14 | 1.03 |

# J & L Sheet Piling



## Properties of Combined Sections
## Joints Considered as a Unit

| Section Index | Size, Inches | Weight per Square Ft. of Assembled Area, Pounds | Total Sectional Area Assembled Section, Sq. Inches | Width of Joint Over All, Inches | Moment of Inertia Neutral Axis Coincident with Center Line of Web | Radius of Gyration Neutral Axis Coincident with Center Line of Web | Section Factor Neutral Axis Coincident with Center Line of Web |
|---|---|---|---|---|---|---|---|
| 000 | 12x4¼ | 32.0 | 9.84 | 4¼ | 9.42 | 0.99 | 4.85 |
| 00 | 12x4¼ | 33.5 | 10.32 | 4¼ | 9.52 | 0.96 | 4.90 |
| 0 | 12x4¼ | 35.0 | 10.76 | 4¼ | 9.54 | 0.94 | 4.91 |
| 1 | 12x5 | 35.0 | 10.59 | 5 | 14.93 | 1.19 | 6.45 |
| 2 | 12x5 | 36.25 | 10.97 | 5 | 15.06 | 1.17 | 6.50 |
| 3 | 15x6 | 37.20 | 14.11 | 5 | 26.94 | 1.38 | 9.73 |
| 4 | 15x6 | 39.75 | 15.05 | 5 | 27.33 | 1.35 | 9.84 |
| 5 | 15x6 | 42.25 | 15.98 | 5 | 27.73 | 1.31 | 9.96 |

# J & L Sheet Piling

## Unlocking Tests

The following table shows the result of a series of tests made on J & L Sheet Piling to determine the strength of the interlock.

Pieces of the proper length were locked together, placed in the grips of a 200,000 pound Riehle Testing Machine and a pull exerted which would tend to "unlock" the beams and locking bars. This table shows actual results from tests on nine different sets of beams and locking bars.

**12-inch Piling Beams—4¼-inch Locking Bars**
**Medium Grade Open Hearth Steel**

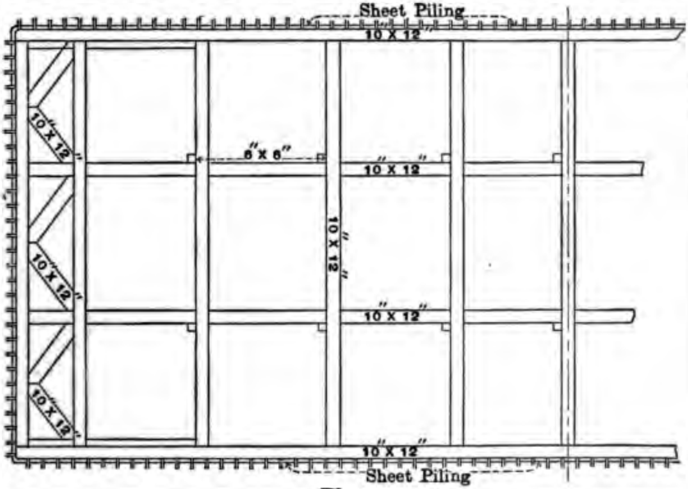
| Set No. | Section Index | Weight per Square Foot | Resistance per Linear Inch of Section |
|---|---|---|---|
| 1 | 000 | 32 pounds | 13,010 pounds |
| 2 | 000 | 32 pounds | 13,360 pounds |
| 3 | 000 | 32 pounds | 13,420 pounds |
| 4 | 0 | 35 pounds | 12,650 pounds |
| 5 | 0 | 35 pounds | 13,040 pounds |
| 6 | 0 | 35 pounds | 12,450 pounds |
| 7 | 0 | 35 pounds | 12,500 pounds |
| 8 | 0 | 35 pounds | 12,350 pounds |
| 9 | 0 | 35 pounds | 13,240 pounds |

The strength of an interlock or grip at a joint is important, especially where there is a tension in a wall of piling tending to "unlock" the sections at the joints. Such tension usually exists in double wall dams, or in any enclosure where the pressure is exerted outwardly, usually caused by an earthen or concrete filling. The joints in a wall of piling, used as a retaining wall, are also very often subjected to pressures, causing heavy tension.

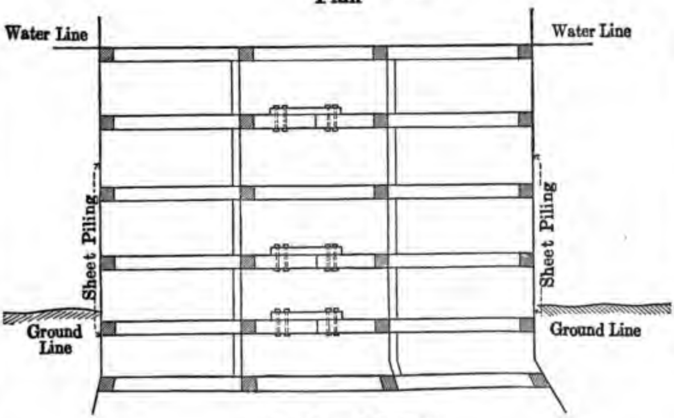
*The table above will* show, at a glance, that J & L Sheet Piling *has been designed to* take care of these conditions. The strength *of interlock is in* excess of any sheet piling now on the market.

# J & L Sheet Piling

## Plan and Sectional View of Cofferdam showing Typical Timber Bracing



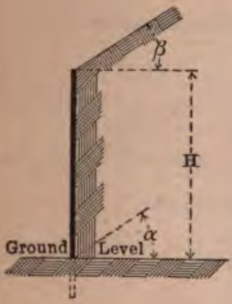

**Plan**




**Sectional View**

# Steel Piling for Retaining Earth

## Formulae




Let $W$ = Weight of a cubic foot of soil retained, in lbs.

$H$ = Height of steel piling above ground on outside, in feet.

$\alpha$ = Angle of repose of soil. (See following tables.)

$\beta$ = Angle of slope of earth retained (if any).

$P$ = Pressure on each lineal foot of the steel sheet piling wall, in lbs.

Then $P = \dfrac{WH^2}{2} \times \dfrac{1 - \sin\alpha}{1 + \sin\alpha}$ when $\beta = o$

$$P = \frac{WH^2 \cos\alpha}{2} \text{ when } \beta = \alpha$$

$$P = \cos\beta \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\alpha}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\alpha}} \times \frac{WH^2}{2} \text{ for any other slope.}$$

In the following examples let

$W$ = 100 lbs. per cubic foot

$H$ = 30 feet

$\alpha$ = 36° 53′ for soil

1. Then, when $\beta = o$

$$P = \frac{WH^2}{2} \times \frac{1 - \sin 36° 53',}{1 + \sin 36° 53'} = \frac{100 \times 900}{2} \times \frac{1 - .6}{1 + .6}$$
$$= 45{,}000 \times .25 = 11{,}250 \text{ lbs. or } 5.63 \text{ tons.}$$

2. When $\beta$ = say 20°

$$P = \frac{WH^2}{2} \cos 20° \frac{\cos 20° - \sqrt{\cos^2 20° - \cos^2 36° 53'}}{\cos 20° + \sqrt{\cos^2 20° - \cos^2 36° 53'}}$$
$$= \frac{100 \times 900}{2} \times .939 \times \frac{.939 - .493}{.939 + .493}$$
$$= 45{,}000 \times .293 = 13{,}185 \text{ lbs. or } 6.6 \text{ tons.}$$

3. When $\beta = 36° 53' = \alpha$

$$P = \frac{WH^2}{2} \cos 36° 53'$$
$$= \frac{100 \times 900}{2} \times .8 = 36{,}000 \text{ lbs. or } 18 \text{ tons.}$$

# Steel Piling for Retaining Earth

Continued

## Slope of Repose and Weights for Loose Earth

| Kind of Earth | Slope of Repose | Angle of Repose | Weight, Pounds per Cubic Foot |
|---|---|---|---|
| Sand, clean | 1.5 to 1 | 33° 41′ | 100 |
| Sand and Clay | 1.33 to 1 | 36° 53′ | 100 |
| Clay, dry | 1.33 to 1 | 36° 53′ | 100 |
| Clay, damp, plastic | 2.00 to 1 | 26° 34′ | 100 |
| Gravel, clean | 1.33 to 1 | 36° 53′ | 100 |
| Gravel and Clay | 1.33 to 1 | 36° 53′ | 100 |
| Gravel, Sand and Clay | 1.33 to 1 | 36° 53′ | 100 |
| Soil | 1.33 to 1 | 36° 53′ | 100 |
| Soft Rotten Rock | 1.33 to 1 | 36° 53′ | 110 |
| Hard Rock | 1 to 1 | 45° 0′ | 100 |
| Bituminous Cinders | 1 to 1 | 45° 0′ | 50 |
| Anthracite Ashes | 1 to 1 | 45° 0′ | 30 |

## Material Excavated by a Wet or Dry Process and dumped into Water, as at the Back of a Sea-Wall, has Weights and Slopes approximately as follows

| Kind of Material | Slope of Repose | Angle of Repose | Weight, Pounds per Cubic Foot |
|---|---|---|---|
| Sand, clean | 2 to 1 | 26° 34′ | 60 |
| Sand and Clay | 3 to 1 | 18° 26′ | 65 |
| Clay | 3½ to 1 | 15° 57′ | 80 |
| Gravel, clean | 2 to 1 | 26° 34′ | 60 |
| Gravel and Clay | 3 to 1 | 18° 26′ | 65 |
| Gravel, Sand and Clay | 3 to 1 | 18° 26′ | 65 |
| Soil | 3½ to 1 | 15° 57′ | 70 |
| Soft Rotten Rock | 1 to 1 | 45° 0′ | 65 |
| Hard Rock | 1 to 1 | 45° 0′ | 65 |
| River Mud | $\infty$ to 1 | 0° 0′ | 90 |

# Chain

**Straight Link Coil Chain**


**Conveyor or Sprocket Wheel Chain**


**Twist Coil Chain**

# Straight-Link Coil Chain

| Size of Chain, Inches | Length of Link, Inches | Width of Link, Inches | Weight of Chain, per Foot | Proof Test for BB Chain | Proof Test for BBB Chain | Proof Test for Dredge Chain |
|---|---|---|---|---|---|---|
| t | l | W | Pounds | Tons | Tons | Tons |
| 3/16 | 1 3/8 | 13/16 | .50 | .39 | .45 | .50 |
| 1/4 | 1 1/2 | 1 | .75 | .66 | .75 | .80 |
| 5/16 | 1 3/4 | 1 3/16 | 1.10 | 1.37 | 1.60 | 1.70 |
| 3/8 | 2 | 1 3/8 | 1.55 | 1.92 | 2.21 | 2.36 |
| 7/16 | 2 1/4 | 1 9/16 | 2.00 | 2.64 | 3.05 | 3.33 |
| 1/2 | 2 1/2 | 1 3/4 | 2.65 | 3.41 | 3.92 | 4.42 |
| 9/16 | 2 7/8 | 1 15/16 | 3.25 | 4.29 | 4.93 | 5.53 |
| 5/8 | 3 1/4 | 2 1/8 | 4.20 | 5.28 | 6.07 | 6.67 |
| 11/16 | 3 1/2 | 2 5/16 | 5.00 | 6.32 | 7.28 | 8.02 |
| 3/4 | 3 3/4 | 2 1/2 | 5.90 | 7.59 | 8.74 | 9.24 |
| 13/16 | 4 | 2 11/16 | 7.00 | 8.91 | 10.3 | 10.7 |
| 7/8 | 4 1/4 | 3 | 8.00 | 10.3 | 11.9 | 12.1 |
| 15/16 | 4 1/2 | 3 1/4 | 9.00 | 11.8 | 13.6 | 14.5 |
| 1 | 4 3/4 | 3 1/2 | 10.0 | 13.5 | 15.6 | 16.3 |
| 1 1/8 | 5 1/2 | 3 7/8 | 12.5 | 16.2 | 18.6 | 19.6 |
| 1 1/4 | 6 | 4 1/4 | 16.0 | 20.1 | 23.1 | 24.0 |
| 1 3/8 | 6 1/2 | 4 3/4 | 19.0 | 24.2 | 27.8 | 28.7 |
| 1 1/2 | 7 1/4 | 5 1/4 | 21.0 | 28.9 | 33.2 | 34.6 |
| 1 5/8 | 7 7/8 | 5 3/4 | 25.0 | 34.9 | 39.0 | 41.0 |

**Safe working loads of chain are one-half of proof test loads.** Twist Coil *Chain is made* in all sizes from 3/16" to 3/4" inclusive. Conveyor or Sprocket *Wheel Chain is* made to any dimensions required, and in ordering give *dimensions of links* wanted, or preferably a sketch of same.

# Chain

Standard
Stud-Link
Cable Chain


Standard
Close-Link
Cable Chain

# Standard Stud-Link Cable Chain

| Size of Chain, Inches | Length of Link, Inches | Width of Link, Inches | Weight of Chain, per Foot | Proof Test |
|---|---|---|---|---|
| t | l | W | Pounds | Tons |
| 3/4 | 4 3/8 | 2 3/4 | 5.5 | 10.1 |
| 13/16 | 4 3/4 | 3 | 6.3 | 12.0 |
| 7/8 | 5 | 3 1/4 | 8.2 | 13.7 |
| 15/16 | 5 3/8 | 3 1/2 | 9.2 | 15.7 |
| 1 | 5 7/8 | 3 3/4 | 10.2 | 18.0 |
| 1 1/16 | 6 1/4 | 3 7/8 | 11.5 | 20.3 |
| 1 1/8 | 6 1/2 | 4 1/8 | 12.3 | 22.8 |
| 1 3/16 | 6 3/4 | 4 1/4 | 13.5 | 25.5 |
| 1 1/4 | 7 1/8 | 4 1/2 | 15.0 | 28.1 |
| 1 5/16 | 7 3/8 | 4 5/8 | 16.2 | 31.0 |
| 1 3/8 | 7 3/4 | 4 7/8 | 18.3 | 34.0 |
| 1 7/16 | 8 1/8 | 5 1/8 | 18.8 | 37.2 |
| 1 1/2 | 8 1/2 | 5 3/8 | 21.2 | 40.5 |
| 1 9/16 | 8 7/8 | 5 5/8 | 23.8 | 44.0 |
| 1 5/8 | 9 1/4 | 5 7/8 | 25.0 | 47.5 |
| 1 11/16 | 9 5/8 | 6 | 26.2 | 51.2 |
| 1 3/4 | 10 | 6 1/4 | 28.8 | 55.2 |
| 1 7/8 | 10 1/2 | 6 3/4 | 33.8 | 63.3 |
| 1 15/16 | 10 3/4 | 7 | 35.8 | 67.5 |
| 2 | 11 1/8 | 7 1/4 | 38.8 | 72.0 |
| 2 1/16 | 11 1/2 | 7 1/2 | 42.3 | 76.5 |
| 2 1/8 | 12 | 7 3/4 | 46.0 | 81.2 |
| 2 3/16 | 12 1/2 | 8 | 48.3 | 86.1 |
| 2 1/4 | 13 | 8 1/4 | 50.0 | 91.0 |

*Safe working loads of chain are one-half of proof test loads.*

# Standard Close-Link Cable Chain

| Size of Chain, Inches | Length of Link, Inches | Width of Link, Inches | Weight of Chain, per Foot | Proof Test |
|---|---|---|---|---|
| t | l | W | Pounds | Tons |
| 1 | 4⅝ | 3½ | 10.3 | 12.0 |
| 1 1/16 | 5 | 3⅝ | 11.8 | 12.5 |
| 1⅛ | 5⅜ | 3⅞ | 12.7 | 15.1 |
| 1 3/16 | 5½ | 4⅛ | 13.7 | 16.9 |
| 1¼ | 5¾ | 4¼ | 15.2 | 18.7 |
| 1 5/16 | 6 | 4½ | 16.5 | 20.6 |
| 1⅜ | 6¼ | 4¾ | 18.8 | 22.6 |
| 1 7/16 | 6⅝ | 5 | 19.7 | 24.7 |
| 1½ | 6⅞ | 5¼ | 21.7 | 27.0 |
| 1 9/16 | 7¼ | 5½ | 23.0 | 29.2 |
| 1⅝ | 7½ | 5¾ | 25.3 | 31.6 |

Safe working loads of chain are one-half of proof test loads.

# Properties of Sections

## Definitions and Mathematical Expressions Used in Structural Designing

$A$ = AREA OF SECTION, given in square inches.

$I$ = MOMENT OF INERTIA. For any cross-section, the moment of inertia is the sum of the products obtained by multiplying the area of each particle in the cross-section by the square of its distance from the neutral axis.

$r$ = RADIUS OF GYRATION. This may be defined as the distance from the neutral axis to the point at which, if all the area were concentrated, the moment of inertia would be the same.

The radius of gyration is used for ascertaining the safe load any section or shape will sustain when used in compression as a strut or column. The unbraced length of the section in inches, divided by the radius of gyration in inches is the working basis of all column formulae, commonly written $\frac{l}{r}$

The value of the radius of gyration of any section is determined by the formulae, $r = \frac{I}{A}$

NEUTRAL AXIS = Axis of moments through center of gravity of sections.

$x$–$x$ and $y$–$y$ = The neutral axis through center of gravity of unsymmetrical sections.

$x$ and $y$ = The distance from neutral axis $x$–$x$ and $y$–$y$ to the back or working line of this section.

$S$ = SECTION MODULUS

The moment of inertia divided by the distance from axis to extreme fiber $= \frac{I}{n}$

The section modulus is used to determine the stress in the extreme fiber of a shape subject to bending, by dividing the bending moment by the section modulus, both expressed in like units of measurement.

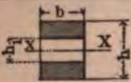
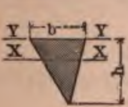
In an unsymmetrical section there are two section moduli for each axis, the least of which determines the safe unit stress.

The properties of steel sections are based upon the theoretical dimensions given in pages 11 to 45 inclusive. No account has been taken of fillets or rounded corners, neither have any approximations entered into any of the calculations.

# Values of Moments of Inertia

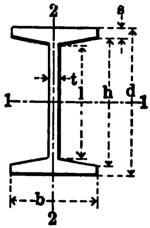
## Various Sections

$I$ = Moment of Inertia $S$ = Section Factor

| Sections | I | S |
|---|---|---|
|  | For axis X–X $= \dfrac{b\,h^3}{12}$ <br> For axis Y–Y $= \dfrac{b\,h^3}{3}$ | $\dfrac{b\,h^2}{6}$ |
|  | $\dfrac{b\,(h^3 - h_1^3)}{12}$ | $\dfrac{b\,(h^3 - h_1^3)}{6\,h}$ |
|  | $\dfrac{b\,h^3 - b_1 h_1^3}{12}$ | $\dfrac{b\,h^3 - b_1\,h_1^3}{6\,h}$ |
|  | For axis X–X $= \dfrac{b\,h^3}{36}$ <br> For axis Y–Y $= \dfrac{b\,h^3}{12}$ | Min. $= \dfrac{b\,h^2}{24}$ |
|  | $\dfrac{\pi\,d^4}{64}$ | $\dfrac{\pi\,d^3}{32}$ |
|  | $\dfrac{\pi\,(d^4 - d_1^4)}{64}$ | $\dfrac{\pi\,(d^4 - d_1^4)}{32\,d}$ |
|  | $\dfrac{\pi\,b\,h^3}{64}$ | $\dfrac{\pi\,b\,h^2}{32}$ |
|  | $\dfrac{b\,h^3 - (b - b_1)\,h_1^3}{12}$ | $\dfrac{2\,I}{h}$ |

# Values of Moments of Inertia

## Rolled Steel Sections



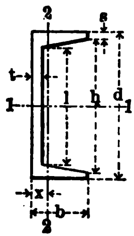
$$A = td + 2s\,(b - t) + \frac{(b - t)^2}{12}$$

$$I,\ \text{Axis } 1\text{—}1 = \frac{bd^3}{12} - \frac{h^4 - l^4}{8}$$

$$I',\ \text{Axis } 2\text{—}2 = \frac{b^3 s}{6} + \frac{lt^3}{12} + \frac{b^4 - t^4}{288}$$

Slope of flange $= g = \dfrac{h - l}{b - t} = \dfrac{1}{6}$ for standard sections

$h = d - 2s \qquad l = h - g\,(b - t)$



$$A = td + 2s\,(b - t) + \frac{(b - t)^2}{6}$$

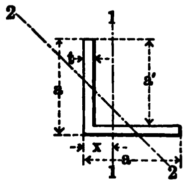
$$X = \left[b^2 s + \frac{ht^2}{2} + \frac{(b - t)^2\,(b + 2t)}{18}\right] \div A$$

$$I,\ \text{Axis } 1\text{—}1 = \frac{bd^3}{12} - \frac{h^4 - l^4}{16}$$

$$I',\ \text{Axis } 2\text{—}2 = \frac{1}{3}\left[2sb^3 + l\,t^3 + \frac{b^4 - t^4}{12}\right] - AX^2$$

Slope of flange $= g = \dfrac{h - l}{2\,(b - t)} = \dfrac{1}{6}$ for standard sections.

$h = d - 2s \qquad l = h - 2g\,(b - t)$



$$A = t\,(2a - t)$$

$$X = \frac{a^2 + a\,t - t^2}{2\,(2a - t)}$$

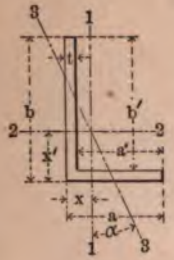
$$I,\ \text{Axis } 1\text{—}1 = \frac{t\,(a - x)^3 + ax^3 - (a - t)\,(x - t)^3}{3}$$

$$I'',\ \text{Axis } 2\text{—}2 = \frac{2x^4 - 2(x - t)^4 + t\left[a - \left(2x - \frac{t}{2}\right)\right]^3}{3}$$

# Values of Moments of Inertia

## Rolled Steel Sections

### Continued




$$A = t\,(a + b - t)$$

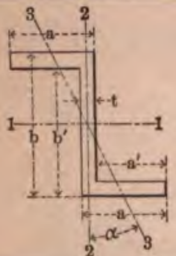
$$X = \frac{t\,(2a' + b) + a'^2}{2\,(a' + b)} \quad X' = \frac{t\,(2b' + a) + b'^2}{2\,(b' + a)}$$

$$\text{Tan } 2\alpha = -\frac{[(2x-t)b(b-2x') + (2x'-t)(a-t)(a+t-2x)]t}{2\,(I' - I)}$$

$$I, \text{ Axis } 1\text{—}1 = \frac{t\,(a - x)^3 + bx^3 - (b - t)\,(x - t)^3}{3}$$

$$I', \text{ Axis } 2\text{—}2 = \frac{t\,(b - x')^3 + ax'^3 - (a - t)\,(x' - t)^3}{3}$$

$$I'', \text{ Axis, } 3\text{—}3 = \frac{I \cos^2 a - I' \sin^2 a}{\cos 2a}$$



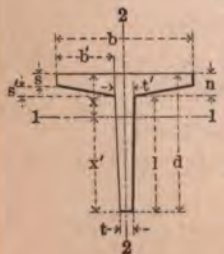

$$A = [b + 2\,(a - t)]\,t$$

$$\text{Tan } 2\alpha = -\frac{(bt - t^2)\,(a^2 - at)}{I - I'}$$

$$I, \text{ Axis } 1\text{—}1 = \frac{ab^3 - a'\,(b - 2t)^3}{12}$$

$$I', \text{ Axis } 2\text{—}2 = \frac{b\,(a + a')^3 - 2a'^3\,b' - 6a'\,a^2\,b'}{12}$$

$$I'' \text{ Minimum, Axis } 3\text{—}3 \quad \frac{I' \cos^2 a - I \sin^2 a}{\cos 2a}$$




$$A \quad \frac{l\,(t + t')}{2} + n\,t' + b'\,(s + n)$$

$$X = \frac{3s^2(b-t') + 2b's'(s'+3s) + 3t'd^2 - l(t'-t)(3d-l)}{6A}$$

$$I, \text{Axis } 1\text{—}1 = \frac{l^3(3t+t') + 4bn^3 - 2b's'^3}{12} - A(x-n)^2$$

$$I', \text{Axis } 2\text{—}2 = \frac{sb^3 + s't'^3 + lt^3}{12} + \frac{s'b'\,[2b'^2 + (2b' + 3t')^2]}{36} + \frac{l\,(t'-t)\,[(t'-t)^2 + 2\,(t'+2t)^2]}{144}$$

# Compound Sections

## Method of Finding Moments of Inertia, Radii of Gyration and Section Moduli

The moment of inertia $I$ of a compound section about its neutral axis is equal to the sum of the moments of inertia $I'$, of its component parts about axes through their own centers of gravity and parallel to the neutral axis of the compound section, plus areas $A'$ of the component parts multiplied by the squares of the distances $d$, of their own centers of gravity from the neutral axis of the compound section.

$$\text{Moment of inertia } I = I' + A'd^2$$

$$\text{Radius of gyration } r = \sqrt{\frac{I}{A}}$$

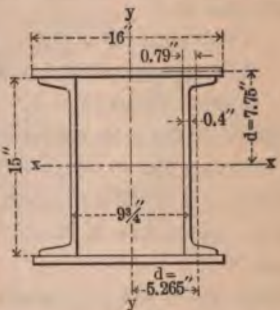
$$\text{Section modulus } S = \frac{I}{n}$$

Where $n$ = distance of extreme fiber from neutral axis of compound section.

Example 1. Find the moments of inertia and radii of gyration about the axes X–X and Y–Y of a column section composed of

2 channels 15″ × 33 lbs. per ft.
2 cover plates 16 × ½

considering the gross area of section.




The properties of the component sections will be found tabulated in other parts of the book. Calculate the distances $d$ from the neutral axes of the component sections to the neutral axes X–X and Y–Y in accordance with dimensions given in sketch.

Axis X–X

| | | |
|---|---|---|
| $Ix\text{-}x$ of 2–15″ channels 33 lbs. $= 2 \times 312.6$ | = | 625.20 inches$^4$ |
| $Ix\text{-}x$ of 2–16 × ½″ plates $= 2 \times \dfrac{16 \times 0.5^3}{12}$ | = | .33 inches$^4$ |
| $Ad^2$ of 2–16 × ½″ plates $= 2 \times 8 \times 7.75^2$ | = | 961.00 inches$^4$ |
| Moment of inertia—gross section | = | 1586.53 inches$^4$ |
| Radius of gyration—gross section $\sqrt{\dfrac{1586.53}{35.8}}$ | = | 6.66 inches |

## Compound Sections

**Continued**

Axis Y–Y

*Iy-y* of 2–15″ channels 33 lbs. $= 2 \times 8.2 \quad = \quad 16.40$ inches$^4$

$Ad^2$ of 2–15″ channels 33 lbs. $= 2 \times 9.9 \times 5.265^2 = 548.86$ inches$^4$

*Iy-y* of 2–16 × ½ plates $= 2 \times \dfrac{0.5 \times 16^3}{12} = 341.33$ inches$^4$

---

Moment of inertia—gross section $= 906.59$ inches$^4$

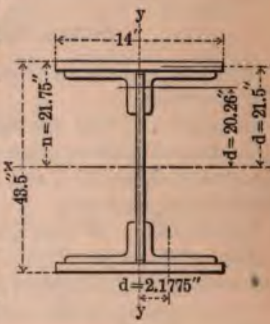
Radius of gyration—gross section $\sqrt{\dfrac{906.59}{35.8}} = 5.03$ inches

Example 2. Find the moments of inertia and section moduli about the axes X–X and Y–Y of a girder section composed of

1 web plate 42″ × ⅜″
4 flange angles 6 × 4 × ½″
2 flange plates 14 × ½″

considering the gross area of section.

Calculate the distances *d* from the neutral axes of the component sections to the neutral axes X–X and Y–Y.




Axis X–X

*Ix-x* of 4–6 × 4 × ½ angles $= 4 \times 6.3 \quad = \quad 25.20$ inches$^4$

$Ad^2$ of 4–6 × 4 × ½ angles $= 4 \times 4.75 \times 20.26^2 = 7798.88$ inches$^4$

*Ix-x* of 1–42 × ⅜ plate $= 1 \times \dfrac{0.375 \times 42^3}{12} = 2315.25$ inches$^4$

*Ix-x* of 2–14 × ½ plates $= 2 \times \dfrac{14 \times 0.5^3}{12} = .29$ inches$^4$

$Ad^2$ of 2–14 × ½ plates $= 2 \times 7 \times 21.5^2 = 6471.50$ inches$^4$

---

Moment of inertia—gross section $= 16611.12$ inches$^4$

Section modulus—gross section $\dfrac{16611.2}{21.75} = 763.72$ inches

## Compound Sections

Continued

Axis Y–Y

$Iy\text{-}y$ of 4–6 × 4 × ½ angles = 4 × 17.4 = 69.60 inches$^4$

$Ad^2$ of 4–6 × 4 × ½ angles = 4 × 4.75 × 2.1775$^2$ = 90.09 inches$^4$

$Iy\text{-}y$ of 1–42 × ⅜ plate $= 1 \times \dfrac{42 \times 0.375^3}{12}$ = .49 inches$^4$

$Iy\text{-}y$ of 2–14 × ½ plates $= 2 \times \dfrac{0.5 \times 14^3}{12}$ = 228.67 inches$^4$

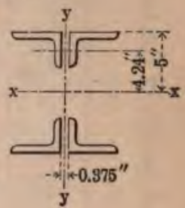
Moment of inertia—gross section = 388.85 inches$^4$

Section modulus—gross section $\dfrac{388.85}{7}$ = 55.55 inches

To find the moment of inertia of the net section calculate the moments of inertia of the areas of the rivet holes about the neutral axis of the compound section and deduct their sum from the moment of inertia of the gross section as determined above.

Example 3. Find the radii of gyration about axes X–X and Y–Y of a latticed column composed of

4–4 × 3 × $\frac{5}{16}$ angles with ⅜″ lattice bars considering gross section of angles, no allowance being made for lattice bars. Calculate the distance $d$ from the neutral axis of the angles to the neutral axis X–X.




Axis X–X

$Ix\text{-}x$ of 4–4 × 3 × $\frac{5}{16}$ angles = 4 × 1.7 = 6.8 inches$^4$

$Ad^2$ of 4–4 × 3 × $\frac{5}{16}$ angles = 4 × 2.09 × 4.24$^2$ = 150.29 inches$^4$

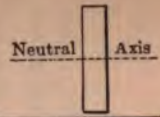
Moment of inertia—gross section = 157.09 inches$^4$

Radius of gyration—gross section $\sqrt{\dfrac{157.09}{8.36}}$ = 4.34 inches

Axis Y–Y

$Iy\text{-}y$ of 4–4 × 3 × $\frac{5}{16}$ angles = 1.93. See tables of radii of gyration for 2 angles placed back to back (page 209).

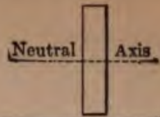
# Moments of Inertia of Rectangles




| Depth, Inches | Width of Rectangle, Inches ¼ | $\frac{5}{16}$ | ⅜ | $\frac{7}{16}$ | ½ | $\frac{9}{16}$ | ⅝ | ¾ | 1 |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 2.60 | 3.26 | 3.91 | 4.56 | 5.21 | 5.86 | 6.51 | 7.81 | 10.42 |
| 6 | 4.50 | 5.63 | 6.75 | 7.88 | 9.00 | 10.13 | 11.25 | 13.50 | 18.00 |
| 7 | 7.15 | 8.93 | 10.72 | 12.51 | 14.29 | 16.08 | 17.86 | 21.44 | 28.58 |
| 8 | 10.67 | 13.33 | 16.00 | 18.67 | 21.33 | 24.00 | 26.67 | 32.00 | 42.67 |
| 9 | 15.19 | 18.98 | 22.78 | 26.58 | 30.38 | 34.17 | 37.97 | 45.56 | 60.75 |
| 10 | 20.83 | 26.04 | 31.25 | 36.46 | 41.67 | 46.87 | 52.08 | 62.50 | 83.33 |
| 11 | 27.73 | 34.66 | 41.59 | 48.53 | 55.46 | 62.39 | 69.32 | 83.19 | 110.92 |
| 12 | 36.00 | 45.00 | 54.00 | 63.00 | 72.00 | 81.00 | 90.00 | 108.00 | 144.00 |
| 13 | 45.77 | 57.21 | 68.66 | 80.10 | 91.54 | 102.98 | 114.43 | 137.31 | 183.08 |
| 14 | 57.17 | 71.46 | 85.75 | 100.04 | 114.33 | 128.63 | 142.92 | 171.50 | 228.67 |
| 15 | 70.31 | 87.89 | 105.47 | 123.05 | 140.63 | 158.20 | 175.78 | 210.94 | 281.25 |
| 16 | 85.33 | 106.67 | 128.00 | 149.33 | 170.67 | 192.00 | 213.33 | 256.00 | 341.33 |
| 17 | 102.35 | 127.94 | 153.53 | 179.12 | 204.71 | 230.30 | 255.89 | 307.06 | 409.42 |
| 18 | 121.50 | 151.88 | 182.25 | 212.63 | 243.00 | 273.38 | 303.75 | 364.50 | 486.00 |
| 19 | 142.90 | 178.62 | 214.34 | 250.07 | 285.79 | 321.52 | 357.24 | 428.69 | 571.58 |
| 20 | 166.67 | 208.33 | 250.00 | 291.67 | 333.33 | 375.00 | 416.67 | 500.00 | 666.67 |
| 21 | 192.94 | 241.17 | 289.41 | 337.64 | 385.88 | 434.11 | 482.34 | 578.81 | 771.75 |
| 22 | 221.83 | 277.29 | 332.75 | 388.21 | 443.67 | 499.13 | 554.58 | 665.50 | 887.33 |
| 23 | 253.48 | 316.85 | 380.22 | 443.59 | 506.96 | 570.33 | 633.70 | 760.44 | 1013.92 |
| 24 | 288.00 | 360.00 | 432.00 | 504.00 | 576.00 | 648.00 | 720.00 | 864.00 | 1152.00 |

# Moments of Inertia of Rectangles

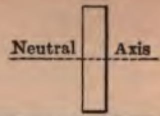
**Continued**




| Depth, Inches | Width of Rectangle, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 3/4 | 1 |
| 25 | 325.52 | 406.90 | 488.28 | 569.66 | 651.04 | 732.42 | 813.80 | 976.56 | 1302.08 |
| 26 | 366.17 | 457.71 | 549.25 | 640.79 | 732.33 | 823.88 | 915.42 | 1098.50 | 1464.67 |
| 27 | 410.06 | 512.58 | 615.09 | 717.61 | 820.13 | 922.64 | 1025.16 | 1230.19 | 1640.25 |
| 28 | 457.33 | 571.67 | 686.00 | 800.33 | 914.67 | 1029.00 | 1143.33 | 1372.00 | 1829.33 |
| 29 | 508.10 | 635.13 | 762.16 | 889.18 | 1016.21 | 1143.23 | 1270.26 | 1524.31 | 2032.42 |
| 30 | 562.50 | 703.13 | 843.75 | 984.38 | 1125.00 | 1265.63 | 1406.25 | 1687.50 | 2250.00 |
| 31 | 620.65 | 775.81 | 930.97 | 1086.13 | 1241.30 | 1396.46 | 1551.62 | 1861.95 | 2482.60 |
| 32 | 682.67 | 853.33 | 1024.00 | 1194.67 | 1365.33 | 1536.00 | 1706.67 | 2048.00 | 2730.67 |
| 33 | 748.69 | 935.86 | 1123.03 | 1310.20 | 1497.38 | 1684.55 | 1871.72 | 2246.07 | 2994.76 |
| 34 | 818.83 | 1023.54 | 1228.25 | 1432.96 | 1637.67 | 1842.38 | 2047.08 | 2456.50 | 3275.33 |
| 35 | 893.23 | 1116.54 | 1339.84 | 1563.15 | 1786.46 | 2009.76 | 2233.07 | 2679.69 | 3572.92 |
| 36 | 972.00 | 1215.00 | 1458.00 | 1701.00 | 1944.00 | 2187.00 | 2430.00 | 2916.00 | 3888.00 |
| 37 | 1055.27 | 1319.09 | 1582.90 | 1846.72 | 2110.54 | 2374.35 | 2638.17 | 3165.81 | 4221.08 |
| 38 | 1143.17 | 1428.96 | 1714.75 | 2000.54 | 2286.33 | 2572.13 | 2857.92 | 3429.50 | 4572.67 |
| 39 | 1235.81 | 1544.77 | 1853.72 | 2162.67 | 2471.62 | 2780.58 | 3089.53 | 3707.43 | 4943.24 |

## Moments of Inertia of Rectangles

**Continued**




| Depth, Inches | Width of Rectangle, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ¼ | $\frac{5}{16}$ | ⅜ | $\frac{7}{16}$ | ½ | $\frac{9}{16}$ | ⅝ | ¾ | 1 |
| 40 | 1333.33 | 1666.67 | 2000.00 | 2333.33 | 2666.67 | 3000.00 | 3333.33 | 4000.00 | 5333.33 |
| 41 | 1435.85 | 1794.82 | 2153.78 | 2512.75 | 2871.71 | 3230.69 | 3589.64 | 4307.56 | 5743.42 |
| 42 | 1543.50 | 1929.38 | 2315.25 | 2701.13 | 3087.00 | 3472.88 | 3858.75 | 4630.50 | 6174.00 |
| 43 | 1656.39 | 2070.49 | 2484.59 | 2898.68 | 3312.79 | 3726.89 | 4140.98 | 4969.18 | 6625.59 |
| 44 | 1774.67 | 2218.33 | 2662.00 | 3105.67 | 3549.33 | 3993.00 | 4436.67 | 5324.00 | 7098.67 |
| 45 | 1898.44 | 2373.05 | 2847.66 | 3322.27 | 3796.88 | 4271.48 | 4746.09 | 5695.31 | 7593.75 |
| 46 | 2027.83 | 2534.79 | 3041.75 | 3548.71 | 4055.67 | 4562.63 | 5069.58 | 6083.50 | 8111.33 |
| 47 | 2162.98 | 2703.73 | 3244.47 | 3785.22 | 4325.96 | 4866.71 | 5407.45 | 6488.94 | 8651.92 |
| 48 | 2304.00 | 2880.00 | 3456.00 | 4032.00 | 4608.00 | 5184.00 | 5760.00 | 6912.00 | 9216.00 |

# Properties of Structural Beams


| Section Index | Depth of Beam, In. | Weight per Foot, Lbs. | Area of Section, Sq. In. | Width of Flange, In. | Thickness of Web, In. | Axis X—X I | Axis X—X r In. | Axis X—X S | Axis Y—Y I | Axis Y—Y r In. | Axis Y—Y S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B-0 | | 115.0 | 33.98 | 8.000 | 0.750 | 2955.5 | 9.33 | 246.3 | 83.2 | 1.57 | 20.8 |
| B-1 | 24 | 110.0 | 32.48 | 7.938 | 0.688 | 2883.5 | 9.42 | 240.3 | 81.0 | 1.58 | 20.4 |
| B-2 | | 105.0 | 30.98 | 7.875 | 0.625 | 2811.5 | 9.53 | 234.3 | 78.9 | 1.60 | 20.0 |
| B-3 | | 100.0 | 29.41 | 7.254 | 0.754 | 2379.6 | 9.00 | 198.3 | 48.6 | 1.28 | 13.4 |
| B-4 | | 95.0 | 27.94 | 7.193 | 0.693 | 2309.0 | 9.09 | 192.4 | 47.1 | 1.30 | 13.1 |
| B-5 | 24 | 90.0 | 26.47 | 7.131 | 0.631 | 2238.4 | 9.20 | 186.5 | 45.7 | 1.31 | 12.8 |
| B-6 | | 85.0 | 25.00 | 7.070 | 0.570 | 2167.8 | 9.31 | 180.7 | 44.4 | 1.33 | 12.6 |
| B-7 | | 80.0 | 23.32 | 7.000 | 0.500 | 2087.2 | 9.46 | 173.9 | 42.9 | 1.36 | 12.3 |
| B-12 | | 100.0 | 29.41 | 7.284 | 0.884 | 1655.6 | 7.50 | 165.6 | 52.7 | 1.34 | 14.5 |
| B-13 | | 95.0 | 27.94 | 7.210 | 0.810 | 1606.6 | 7.58 | 160.7 | 50.8 | 1.35 | 14.1 |
| B-14 | 20 | 90.0 | 26.47 | 7.137 | 0.737 | 1557.6 | 7.67 | 155.8 | 49.0 | 1.36 | 13.7 |
| B-15 | | 85.0 | 25.00 | 7.063 | 0.663 | 1508.5 | 7.77 | 150.9 | 47.3 | 1.37 | 13.4 |
| B-16 | | 80.0 | 23.73 | 7.000 | 0.600 | 1466.3 | 7.86 | 146.6 | 45.8 | 1.39 | 13.1 |
| B-20 | | 75.0 | 22.06 | 6.399 | 0.649 | 1268.8 | 7.58 | 126.9 | 30.3 | 1.17 | 9.5 |
| B-21 | 20 | 70.0 | 20.59 | 6.325 | 0.575 | 1219.8 | 7.70 | 122.0 | 29.0 | 1.19 | 9.2 |
| B-22 | | 65.0 | 19.08 | 6.250 | 0.500 | 1169.5 | 7.83 | 117.0 | 27.9 | 1.21 | 8.9 |
| *B-23 | | 90.0 | 26.47 | 7.245 | 0.807 | 1260.4 | 6.90 | 140.0 | 52.0 | 1.40 | 14.4 |
| *B-24 | 18 | 85.0 | 25.00 | 7.163 | 0.725 | 1220.7 | 6.99 | 135.6 | 50.0 | 1.42 | 14.0 |
| *B-25 | | 80.0 | 23.53 | 7.082 | 0.644 | 1181.0 | 7.09 | 131.2 | 48.1 | 1.43 | 13.6 |
| *B-26 | | 75.0 | 22.05 | 7.000 | 0.562 | 1141.3 | 7.19 | 126.8 | 46.2 | 1.45 | 13.2 |
| B-27 | | 70.0 | 20.59 | 6.259 | 0.719 | 921.2 | 6.69 | 102.4 | 24.6 | 1.09 | 7.9 |
| B-28 | 18 | 65.0 | 19.12 | 6.177 | 0.637 | 881.5 | 6.79 | 97.9 | 23.5 | 1.11 | 7.6 |
| B-29 | | 60.0 | 17.65 | 6.095 | 0.555 | 841.8 | 6.91 | 93.5 | 22.4 | 1.13 | 7.3 |
| B-30 | | 55.0 | 15.93 | 6.000 | 0.460 | 795.6 | 7.07 | 88.4 | 21.2 | 1.15 | 7.1 |
| B-44 | | 75.0 | 22.06 | 6.292 | 0.882 | 691.2 | 5.60 | 92.2 | 30.7 | 1.18 | 9.8 |
| B-45 | 15 | 70.0 | 20.59 | 6.194 | 0.784 | 663.7 | 5.68 | 88.5 | 29.0 | 1.19 | 9.4 |
| B-46 | | 65.0 | 19.12 | 6.096 | 0.686 | 636.1 | 5.77 | 84.8 | 27.4 | 1.20 | 9.0 |
| B-47 | | 60.0 | 17.67 | 6.000 | 0.590 | 609.0 | 5.87 | 81.2 | 26.0 | 1.21 | 8.7 |
| B-52 | | 55.0 | 16.18 | 5.746 | 0.656 | 511.0 | 5.62 | 68.1 | 17.1 | 1.02 | 5.9 |
| B-53 | 15 | 50.0 | 14.71 | 5.648 | 0.558 | 483.4 | 5.73 | 64.5 | 16.0 | 1.04 | 5.7 |
| B-54 | | 45.0 | 13.24 | 5.550 | 0.460 | 455.9 | 5.87 | 60.8 | 15.1 | 1.07 | 5.4 |
| B-55 | | 42.0 | 12.48 | 5.500 | 0.410 | 441.8 | 5.95 | 58.9 | 14.6 | 1.08 | 5.3 |

*Proposed Sections—Inserted for reference only.

# Properties of Structural Beams

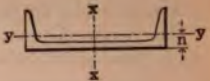
**Continued**


| Section Index | Depth of Beam, In. | Weight per Foot, Lbs. | Area of Section, Sq. In. | Width of Flange, In. | Thickness of Web, In. | Axis X—X | | | Axis Y—Y | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | I | r In. | S | I | r In. | S |
| B-60 | 12 | 55.0 | 16.18 | 5.611 | 0.821 | 321.0 | 4.45 | 53.5 | 17.5 | 1.04 | 6.2 |
| B-61 | | 50.0 | 14.71 | 5.489 | 0.699 | 303.4 | 4.54 | 50.6 | 16.1 | 1.05 | 5.9 |
| B-62 | | 45.0 | 13.24 | 5.366 | 0.576 | 285.7 | 4.65 | 47.6 | 14.9 | 1.06 | 5.6 |
| B-63 | | 40.0 | 11.84 | 5.250 | 0.460 | 269.0 | 4.77 | 44.8 | 13.8 | 1.08 | 5.3 |
| B-68 | 12 | 35.0 | 10.29 | 5.086 | 0.436 | 228.3 | 4.71 | 38.0 | 10.1 | 0.99 | 4.0 |
| B-69 | | 31.5 | 9.26 | 5.000 | 0.350 | 215.8 | 4.83 | 36.0 | 9.5 | 1.01 | 3.8 |
| B-74 | 10 | 40.0 | 11.76 | 5.099 | 0.749 | 158.7 | 3.67 | 31.7 | 9.5 | 0.90 | 3.7 |
| B-75 | | 35.0 | 10.29 | 4.952 | 0.602 | 146.4 | 3.77 | 29.3 | 8.5 | 0.91 | 3.4 |
| B-76 | | 30.0 | 8.82 | 4.805 | 0.455 | 134.2 | 3.90 | 26.8 | 7.7 | 0.93 | 3.2 |
| B-77 | | 25.0 | 7.37 | 4.660 | 0.310 | 122.1 | 4.07 | 24.4 | 6.9 | 0.97 | 3.0 |
| B-82 | 9 | 35.0 | 10.29 | 4.772 | 0.732 | 111.8 | 3.29 | 24.8 | 7.3 | 0.84 | 3.1 |
| B-83 | | 30.0 | 8.82 | 4.609 | 0.569 | 101.9 | 3.40 | 22.6 | 6.4 | 0.85 | 2.8 |
| B-84 | | 25.0 | 7.35 | 4.446 | 0.406 | 91.9 | 3.54 | 20.4 | 5.7 | 0.88 | 2.5 |
| B-85 | | 21.0 | 6.18 | 4.315 | 0.275 | 84.0 | 3.68 | 18.7 | 5.2 | 0.90 | 2.4 |
| B-90 | 8 | 25.5 | 7.50 | 4.271 | 0.541 | 68.4 | 3.02 | 17.1 | 4.8 | 0.80 | 2.2 |
| B-91 | | 23.0 | 6.76 | 4.179 | 0.449 | 64.5 | 3.09 | 16.1 | 4.4 | 0.81 | 2.1 |
| B-92 | | 20.5 | 6.03 | 4.087 | 0.357 | 60.6 | 3.17 | 15.2 | 4.1 | 0.82 | 2.0 |
| B-93 | | 18.0 | 5.33 | 4.000 | 0.270 | 56.9 | 3.27 | 14.2 | 3.8 | 0.84 | 1.9 |
| B-98 | 7 | 20.0 | 5.88 | 3.868 | 0.458 | 42.2 | 2.68 | 12.1 | 3.2 | 0.74 | 1.7 |
| B-99 | | 17.5 | 5.15 | 3.763 | 0.353 | 39.2 | 2.76 | 11.2 | 2.9 | 0.76 | 1.6 |
| B-100 | | 15.0 | 4.42 | 3.660 | 0.250 | 36.2 | 2.86 | 10.4 | 2.7 | 0.78 | 1.5 |
| B-105 | 6 | 17.25 | 5.07 | 3.575 | 0.475 | 26.2 | 2.27 | 8.7 | 2.4 | 0.68 | 1.3 |
| B-106 | | 14.75 | 4.34 | 3.452 | 0.352 | 24.0 | 2.35 | 8.0 | 2.1 | 0.69 | 1.2 |
| B-107 | | 12.25 | 3.61 | 3.330 | 0.230 | 21.8 | 2.46 | 7.3 | 1.9 | 0.72 | 1.1 |
| B-112 | 5 | 14.75 | 4.34 | 3.294 | 0.504 | 15.2 | 1.87 | 6.1 | 1.7 | 0.63 | 1.0 |
| B-113 | | 12.25 | 3.60 | 3.147 | 0.357 | 13.6 | 1.94 | 5.5 | 1.5 | 0.63 | 0.92 |
| B-114 | | 9.75 | 2.87 | 3.000 | 0.210 | 12.1 | 2.05 | 4.8 | 1.2 | 0.65 | 0.82 |
| B-119 | 4 | 10.5 | 3.09 | 2.880 | 0.410 | 7.1 | 1.52 | 3.6 | 1.0 | 0.57 | 0.70 |
| B-120 | | 9.5 | 2.79 | 2.807 | 0.337 | 6.8 | 1.55 | 3.4 | 0.93 | 0.58 | 0.66 |
| B-121 | | 8.5 | 2.50 | 2.733 | 0.263 | 6.4 | 1.59 | 3.2 | 0.85 | 0.58 | 0.62 |
| B-122 | | 7.5 | 2.21 | 2.660 | 0.190 | 6.0 | 1.64 | 3.0 | 0.77 | 0.59 | 0.58 |
| B-127 | 3 | 7.5 | 2.21 | 2.521 | 0.361 | 2.9 | 1.15 | 1.9 | 0.60 | 0.52 | 0.48 |
| B-128 | | 6.5 | 1.91 | 2.423 | 0.263 | 2.7 | 1.19 | 1.8 | 0.53 | 0.52 | 0.44 |
| B-129 | | 5.5 | 1.63 | 2.330 | 0.170 | 2.5 | 1.23 | 1.7 | 0.46 | 0.53 | 0.40 |

# Properties of Structural Channels


| Section Index | Depth of Channel, In. | Wgt. per Foot, Lbs. | Area of Section, Sq. In. | Width of Flange, In. | Thickness of Web, In. | Axis X—X I | Axis X—X r In. | Axis X—X S | Axis Y—Y I | Axis Y—Y r In. | Axis Y—Y S | n In. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C-3 | | 55.0 | 16.18 | 3.818 | 0.818 | 430.2 | 5.16 | 57.4 | 12.2 | 0.87 | 4.1 | 0.82 |
| C-4 | | 50.0 | 14.71 | 3.720 | 0.720 | 402.7 | 5.23 | 53.7 | 11.2 | 0.87 | 3.8 | 0.80 |
| C-5 | 15 | 45.0 | 13.24 | 3.622 | 0.622 | 375.1 | 5.32 | 50.0 | 10.3 | 0.88 | 3.6 | 0.79 |
| C-6 | | 40.0 | 11.76 | 3.524 | 0.524 | 347.5 | 5.43 | 46.3 | 9.4 | 0.89 | 3.4 | 0.78 |
| C-7 | | 35.0 | 10.29 | 3.426 | 0.426 | 319.9 | 5.58 | 42.7 | 8.5 | 0.91 | 3.2 | 0.79 |
| C-8 | | 33.0 | 9.90 | 3.400 | 0.400 | 312.6 | 5.62 | 41.7 | 8.2 | 0.91 | 3.2 | 0.79 |
| C-23 | | 40.0 | 11.76 | 3.418 | 0.758 | 196.9 | 4.09 | 32.8 | 6.6 | 0.75 | 2.5 | 0.72 |
| C-24 | | 35.0 | 10.29 | 3.296 | 0.636 | 179.3 | 4.17 | 29.9 | 5.9 | 0.76 | 2.3 | 0.69 |
| C-25 | 12 | 30.0 | 8.82 | 3.173 | 0.513 | 161.7 | 4.28 | 26.9 | 5.2 | 0.77 | 2.1 | 0.68 |
| C-26 | | 25.0 | 7.35 | 3.050 | 0.390 | 144.0 | 4.43 | 24.0 | 4.5 | 0.79 | 1.9 | 0.68 |
| C-27 | | 20.5 | 6.03 | 2.940 | 0.280 | 128.1 | 4.61 | 21.4 | 3.9 | 0.81 | 1.7 | 0.70 |
| C-32 | | 35.0 | 10.29 | 3.183 | 0.823 | 115.5 | 3.35 | 23.1 | 4.7 | 0.67 | 1.9 | 0.70 |
| C-33 | | 30.0 | 8.82 | 3.036 | 0.676 | 103.2 | 3.42 | 20.7 | 4.0 | 0.67 | 1.7 | 0.65 |
| C-34 | 10 | 25.0 | 7.35 | 2.889 | 0.529 | 91.0 | 3.52 | 18.2 | 3.4 | 0.68 | 1.5 | 0.62 |
| C-35 | | 20.0 | 5.88 | 2.742 | 0.382 | 78.7 | 3.66 | 15.7 | 2.9 | 0.70 | 1.3 | 0.61 |
| C-36 | | 15.0 | 4.46 | 2.600 | 0.240 | 66.9 | 3.87 | 13.4 | 2.3 | 0.72 | 1.2 | 0.64 |
| C-41 | | 25.0 | 7.35 | 2.815 | 0.615 | 70.7 | 3.10 | 15.7 | 3.0 | 0.64 | 1.4 | 0.62 |
| C-42 | 9 | 20.0 | 5.88 | 2.652 | 0.452 | 60.8 | 3.21 | 13.5 | 2.5 | 0.65 | 1.2 | 0.59 |
| C-43 | | 15.0 | 4.41 | 2.488 | 0.288 | 50.9 | 3.40 | 11.3 | 2.0 | 0.67 | 1.0 | 0.59 |
| C-44 | | 13.25 | 3.89 | 2.430 | 0.230 | 47.3 | 3.49 | 10.5 | 1.8 | 0.67 | 0.97 | 0.61 |
| C-49 | | 21.25 | 6.25 | 2.622 | 0.582 | 47.8 | 2.77 | 11.9 | 2.3 | 0.60 | 1.1 | 0.59 |
| C-50 | | 18.75 | 5.51 | 2.530 | 0.490 | 43.8 | 2.82 | 11.0 | 2.0 | 0.60 | 1.0 | 0.57 |
| C-51 | 8 | 16.25 | 4.78 | 2.439 | 0.399 | 39.9 | 2.89 | 10.0 | 1.8 | 0.61 | 0.95 | 0.56 |
| C-52 | | 13.75 | 4.04 | 2.347 | 0.307 | 36.0 | 2.98 | 9.0 | 1.6 | 0.62 | 0.87 | 0.56 |
| C-53 | | 11.25 | 3.35 | 2.260 | 0.220 | 32.3 | 3.11 | 8.1 | 1.3 | 0.63 | 0.79 | 0.58 |
| C-58 | | 19.75 | 5.81 | 2.513 | 0.633 | 33.2 | 2.39 | 9.5 | 1.9 | 0.56 | 0.96 | 0.58 |
| C-59 | | 17.25 | 5.07 | 2.408 | 0.528 | 30.2 | 2.44 | 8.6 | 1.6 | 0.57 | 0.87 | 0.56 |
| C-60 | 7 | 14.75 | 4.34 | 2.303 | 0.423 | 27.2 | 2.50 | 7.8 | 1.4 | 0.57 | 0.79 | 0.54 |
| C-61 | | 12.25 | 3.60 | 2.198 | 0.318 | 24.2 | 2.59 | 6.9 | 1.2 | 0.58 | 0.71 | 0.53 |
| C-62 | | 9.75 | 2.85 | 2.090 | 0.210 | 21.1 | 2.72 | 6.0 | 0.98 | 0.59 | 0.63 | 0.55 |
| C-67 | | 15.5 | 4.56 | 2.283 | 0.563 | 19.5 | 2.07 | 6.5 | 1.3 | 0.53 | 0.74 | 0.55 |
| C-68 | 6 | 13.0 | 3.82 | 2.160 | 0.440 | 17.3 | 2.13 | 5.8 | 1.1 | 0.53 | 0.65 | 0.52 |
| C-69 | | 10.5 | 3.09 | 2.038 | 0.318 | 15.1 | 2.21 | 5.0 | 0.88 | 0.53 | 0.57 | 0.50 |
| C-70 | | 8.0 | 2.38 | 1.920 | 0.200 | 13.0 | 2.34 | 4.3 | 0.70 | 0.54 | 0.50 | 0.52 |
| C-75 | | 11.5 | 3.38 | 2.037 | 0.477 | 10.4 | 1.75 | 4.2 | 0.82 | 0.49 | 0.54 | 0.51 |
| C-76 | 5 | 9.0 | 2.65 | 1.890 | 0.330 | 8.9 | 1.83 | 3.6 | 0.64 | 0.49 | 0.45 | 0.48 |
| C-77 | | 6.5 | 1.95 | 1.750 | 0.190 | 7.4 | 1.95 | 3.0 | 0.48 | 0.50 | 0.38 | 0.49 |
| C-82 | | 7.25 | 2.13 | 1.725 | 0.325 | 4.6 | 1.46 | 2.3 | 0.44 | 0.46 | 0.35 | 0.46 |
| C-83 | 4 | 6.25 | 1.84 | 1.652 | 0.252 | 4.2 | 1.51 | 2.1 | 0.38 | 0.45 | 0.32 | 0.46 |
| C-84 | | 5.25 | 1.55 | 1.580 | 0.180 | 3.8 | 1.56 | 1.9 | 0.32 | 0.45 | 0.29 | 0.46 |
| C-89 | | 6.0 | 1.76 | 1.602 | 0.362 | 2.1 | 1.08 | 1.4 | 0.31 | 0.42 | 0.27 | 0.46 |
| C-90 | 3 | 5.0 | 1.47 | 1.504 | 0.264 | 1.8 | 1.12 | 1.2 | 0.25 | 0.42 | 0.24 | 0.44 |
| C-91 | | 4.0 | 1.19 | 1.410 | 0.170 | 1.6 | 1.17 | 1.1 | 0.20 | 0.41 | 0.21 | 0.44 |

## Properties of Ship Channels

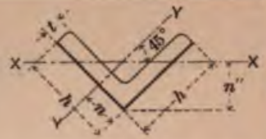



| Section Index | Depth of Channel, Inches | Weight per foot, Pounds | Area of Section, Square Inches | Thickness of Webb, Inches | Width of Flange, Inches | Moment of Inertia Neutral Axis Perpendicular to Web at Center I | Moment of Inertia Neutral Axis Parallel with Center Line of Web I′ | Radius of Gyration Neutral Axis Perpendicular to Web at Center r | Radius of Gyration Neutral Axis Parallel with Center Line of Web r′ | Section Factor Neutral Axis Perpendicular to Web at Center S | Distance of Center of Gravity from Outside of Web |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C-12 | | 52.5 | 15.45 | .848 | 4.473 | 324.2 | 17.4 | 4.58 | 1.06 | 49.9 | 0.99 |
| C-13 | | 50. | 14.71 | .791 | 4.416 | 313.8 | 16.7 | 4.62 | 1.07 | 48.3 | 0.98 |
| C-14 | | 45. | 13.24 | .678 | 4.303 | 293.1 | 15.3 | 4.71 | 1.08 | 45.1 | 0.97 |
| C-15 | 13 | 40. | 11.76 | .565 | 4.190 | 272.3 | 13.9 | 4.81 | 1.09 | 41.9 | 0.97 |
| C-16 | | 37.5 | 11.04 | .509 | 4.134 | 262.1 | 13.4 | 4.87 | 1.10 | 40.3 | 0.98 |
| C-17 | | 35. | 10.29 | .452 | 4.077 | 251.6 | 12.5 | 4.95 | 1.10 | 38.7 | 0.99 |
| C-18 | | 32. | 9.41 | .384 | 4.009 | 239.2 | 11.7 | 5.04 | 1.11 | 36.8 | 1.01 |
| C-19 | | 31.5 | 9.26 | .372 | 3.997 | 237.0 | 11.5 | 5.06 | 1.12 | 36.5 | 1.01 |
| C-101 | 10 | 27.2 | 8.00 | .500 | 3.500 | 109.4 | 7.8 | 3.70 | 0.99 | 21.9 | 0.89 |
| C-102 | | 25.0 | 7.37 | .437 | 3.437 | 104.1 | 7.3 | 3.76 | 0.99 | 20.8 | 0.89 |
| C-105 | 10 | 21.8 | 6.38 | .375 | 3.375 | 91.3 | 6.2 | 3.78 | 0.99 | 18.3 | 0.87 |
| C-107 | | 34.7 | 10.21 | .652 | 4.002 | 115.5 | 13.8 | 3.36 | 1.16 | 25.7 | 1.16 |
| C-108 | 9 | 31.7 | 9.31 | .552 | 3.902 | 109.5 | 12.6 | 3.43 | 1.16 | 24.3 | 1.17 |
| C-109 | | 28.6 | 8.41 | .450 | 3.800 | 103.4 | 11.4 | 3.51 | 1.16 | 23.0 | 1.19 |
| C-114 | | 26.5 | 7.80 | .602 | 3.602 | 67.8 | 8.2 | 2.95 | 1.03 | 17.0 | 0.98 |
| C-115 | 8 | 25.2 | 7.40 | .552 | 3.552 | 65.7 | 7.8 | 2.98 | 1.03 | 16.4 | 0.98 |
| C-116 | | 23.8 | 7.00 | .500 | 3.500 | 63.6 | 7.4 | 3.01 | 1.03 | 15.9 | 0.99 |
| C-117 | | 24.2 | 7.10 | .500 | 3.600 | 65.0 | 8.1 | 3.03 | 1.06 | 16.3 | 1.02 |
| C-118 | 8 | 22.8 | 6.70 | .450 | 3.550 | 62.9 | 7.6 | 3.06 | 1.07 | 15.7 | 1.03 |
| C-119 | | 21.4 | 6.30 | .400 | 3.500 | 60.7 | 7.2 | 3.10 | 1.07 | 15.2 | 1.05 |
| C-121 | | 22.1 | 6.50 | .500 | 3.500 | 46.0 | 7.1 | 2.66 | 1.05 | 13.2 | 1.05 |
| C-122 | 7 | 20.0 | 5.88 | .412 | 3.412 | 43.5 | 6.4 | 2.72 | 1.04 | 12.4 | 1.06 |
| C-123 | | 18.0 | 5.30 | .328 | 3.328 | 41.1 | 5.8 | 2.79 | 1.04 | 11.7 | 1.09 |
| C-128 | | 18.1 | 5.33 | .563 | 3.063 | 25.4 | 3.5 | 2.18 | 0.82 | 8.5 | 0.80 |
| C-129 | | 16.8 | 4.95 | .500 | 3.000 | 24.3 | 3.3 | 2.22 | 0.82 | 8.1 | 0.79 |
| C-130 | 6 | 15.5 | 4.57 | .437 | 2.936 | 23.2 | 3.1 | 2.25 | 0.82 | 7.7 | 0.79 |
| C-131 | | 14.3 | 4.20 | .375 | 2.874 | 22.0 | 2.8 | 2.29 | 0.82 | 7.3 | 0.80 |
| C-132 | | 13.0 | 3.83 | .313 | 2.813 | 20.9 | 2.6 | 2.34 | 0.82 | 7.0 | 0.81 |
| C-137 | 6 | 15.0 | 4.46 | .350 | 3.500 | 25.0 | 5.2 | 2.37 | 1.08 | 8.3 | 1.08 |

# Properties of Angles

## Equal Legs

### Continued

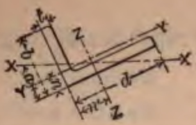



| Section Index | Dimensions, Inches h x h | Thickness, Inches t | Weight per Foot, Pounds | Area of Section, Square Inches A | Distance of Center of Gravity from Back of Leg, Inches n | Moment of Inertia, Axis Y—Y I | Section Factor, Axis Y—Y S | Radius of Gyration, Axis Y—Y, Inches r | Least Radius of Gyration, Axis X—X r" |
|---|---|---|---|---|---|---|---|---|---|
| A-130 | 2½x2½ | ½ | 7.7 | 2.25 | 0.81 | 1.2 | 0.73 | 0.74 | 0.47 |
| A-131 | 2½x2½ | 7/16 | 6.8 | 2.00 | 0.78 | 1.1 | 0.65 | 0.75 | 0.48 |
| A-132 | 2½x2½ | ⅜ | 5.9 | 1.73 | 0.76 | 0.98 | 0.57 | 0.75 | 0.48 |
| A-133 | 2½x2½ | 5/16 | 5.0 | 1.47 | 0.74 | 0.85 | 0.48 | 0.76 | 0.49 |
| A-134 | 2½x2½ | ¼ | 4.1 | 1.19 | 0.72 | 0.70 | 0.39 | 0.77 | 0.49 |
| A-135 | 2½x2½ | 3/16 | 3.07 | 0.90 | 0.69 | 0.55 | 0.30 | 0.78 | 0.49 |
| A-140 | 2½x2½ | ⅛ | 2.08 | 0.61 | 0.67 | 0.38 | 0.20 | 0.79 | 0.50 |
| A-160 | 2x2 | ½ | 6.0 | 1.75 | 0.68 | 0.59 | 0.45 | 0.58 | 0.39 |
| A-161 | 2x2 | 7/16 | 5.3 | 1.56 | 0.66 | 0.54 | 0.40 | 0.59 | 0.39 |
| A-162 | 2x2 | ⅜ | 4.7 | 1.36 | 0.64 | 0.48 | 0.35 | 0.59 | 0.39 |
| A-163 | 2x2 | 5/16 | 3.92 | 1.15 | 0.61 | 0.42 | 0.30 | 0.60 | 0.39 |
| A-164 | 2x2 | ¼ | 3.19 | 0.94 | 0.59 | 0.35 | 0.25 | 0.61 | 0.40 |
| A-165 | 2x2 | 3/16 | 2.44 | 0.71 | 0.57 | 0.27 | 0.19 | 0.62 | 0.40 |
| A-170 | 2x2 | ⅛ | 1.65 | 0.48 | 0.55 | 0.19 | 0.13 | 0.63 | 0.39 |
| A-189 | 1½x1½ | ⅜ | 3.35 | 0.98 | 0.51 | 0.19 | 0.19 | 0.44 | 0.29 |
| A-190 | 1½x1½ | 5/16 | 2.86 | 0.84 | 0.49 | 0.16 | 0.16 | 0.44 | 0.29 |
| A-191 | 1½x1½ | ¼ | 2.34 | 0.69 | 0.47 | 0.14 | 0.13 | 0.45 | 0.29 |
| A-192 | 1½x1½ | 3/16 | 1.80 | 0.53 | 0.44 | 0.11 | 0.10 | 0.46 | 0.29 |
| A-197 | 1½x1½ | ⅛ | 1.23 | 0.36 | 0.42 | 0.08 | 0.07 | 0.46 | 0.30 |
| A-224 | 1x1 | ¼ | 1.49 | 0.44 | 0.34 | 0.04 | 0.06 | 0.29 | 0.19 |
| A-225 | 1x1 | 3/16 | 1.16 | 0.34 | 0.32 | 0.03 | 0.04 | 0.30 | 0.19 |
| A-226 | 1x1 | ⅛ | 0.80 | 0.23 | 0.30 | 0.02 | 0.03 | 0.31 | 0.19 |

# Properties of Angles

## Unequal Legs

| Section Index | Dimensions, Inches d x b | Thickness, Inches t | Weight per Foot, Pounds | Area of Section, Square Inches A | Distance of Center of Gravity from Back of Longer Leg, Inches n | Moment of Inertia, Axis Y—Y I |
|---|---|---|---|---|---|---|
| A-233 | 8 x 6 | 1⅛ | 49.3 | 14.50 | 1.70 | 42.4 |
| A-234 | 8 x 6 | 1 1/16 | 46.8 | 13.77 | 1.68 | 40.7 |
| A-235 | 8 x 6 | 1 | 44.2 | 13.00 | 1.65 | 38.8 |
| A-236 | 8 x 6 | 15/16 | 41.7 | 12.25 | 1.63 | 36.8 |
| A-237 | 8 x 6 | ⅞ | 39.1 | 11.48 | 1.61 | 34.9 |
| A-238 | 8 x 6 | 13/16 | 36.5 | 10.72 | 1.59 | 32.8 |
| A-239 | 8 x 6 | ¾ | 33.8 | 9.94 | 1.56 | 30.7 |
| A-240 | 8 x 6 | 11/16 | 31.2 | 9.15 | 1.54 | 28.6 |
| A-241 | 8 x 6 | ⅝ | 28.5 | 8.36 | 1.52 | 26.3 |
| A-242 | 8 x 6 | 9/16 | 25.7 | 7.56 | 1.50 | 24.0 |
| A-243 | 8 x 6 | ½ | 23.0 | 6.75 | 1.47 | 21.7 |
| A-650 | 8 x 6 | 7/16 | 20.2 | 5.94 | 1.45 | 19.4 |
| A-244 | 7 x 3½ | ⅞ | 28.7 | 8.42 | 0.91 | 6.8 |
| A-245 | 7 x 3½ | 13/16 | 26.8 | 7.87 | 0.89 | 6.5 |
| A-246 | 7 x 3½ | ¾ | 24.9 | 7.31 | 0.87 | 6.1 |
| A-247 | 7 x 3½ | 11/16 | 23.0 | 6.75 | 0.85 | 5.7 |
| A-248 | 7 x 3½ | ⅝ | 21.0 | 6.17 | 0.82 | 5.3 |
| A-249 | 7 x 3½ | 9/16 | 19.1 | 5.59 | 0.80 | 4.9 |
| A-250 | 7 x 3½ | ½ | 17.0 | 5.00 | 0.78 | 4.4 |
| A-251 | 7 x 3½ | 7/16 | 15.0 | 4.40 | 0.75 | 4.0 |
| A-252 | 7 x 3½ | ⅜ | 13.0 | 3.81 | 0.72 | 3.6 |
| A-258 | 6 x 4 | 13/16 | 25.4 | 7.47 | 1.10 | 9.2 |
| A-259 | 6 x 4 | ¾ | 23.6 | 6.94 | 1.08 | 8.7 |
| A-260 | 6 x 4 | 11/16 | 21.8 | 6.40 | 1.06 | 8.1 |
| A-261 | 6 x 4 | ⅝ | 20.0 | 5.86 | 1.03 | 7.5 |
| A-262 | 6 x 4 | 9/16 | 18.1 | 5.31 | 1.01 | 6.9 |
| A-263 | 6 x 4 | ½ | 16.2 | 4.75 | 0.99 | 6.3 |
| A-264 | 6 x 4 | 7/16 | 14.3 | 4.18 | 0.96 | 5.6 |
| A-265 | 6 x 4 | ⅜ | 12.3 | 3.61 | 0.94 | 4.9 |



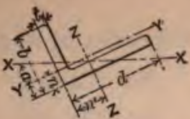
| Section Factor Axis Y—Y<br>S | Radius of Gyration Axis Y—Y, Inches<br>r | Distance of Center of Gravity from Back of Shorter Leg, Inches<br>n′ | Moment of Inertia Axis Z—Z<br>I′ | Section Factor Axis Z—Z<br>S′ | Radius of Gyration Axis Z—Z<br>r′ | Least Radius of Gyration Axis X—X, Inches<br>r″ | Section Index |
|---|---|---|---|---|---|---|---|
| 9.9 | 1.71 | 2.70 | 88.8 | 16.7 | 2.47 | 1.27 | A-233 |
| 9.4 | 1.72 | 2.68 | 84.9 | 15.9 | 2.48 | 1.27 | A-234 |
| 8.9 | 1.73 | 2.65 | 80.8 | 15.1 | 2.49 | 1.28 | A-235 |
| 8.4 | 1.73 | 2.63 | 76.6 | 14.3 | 2.50 | 1.28 | A-236 |
| 7.9 | 1.74 | 2.61 | 72.3 | 13.4 | 2.51 | 1.28 | A-237 |
| 7.4 | 1.75 | 2.59 | 67.9 | 12.5 | 2.52 | 1.29 | A-238 |
| 6.9 | 1.76 | 2.56 | 63.4 | 11.7 | 2.53 | 1.29 | A-239 |
| 6.4 | 1.77 | 2.54 | 58.8 | 10.8 | 2.54 | 1.29 | A-240 |
| 5.9 | 1.77 | 2.52 | 54.1 | 9.9 | 2.54 | 1.30 | A-241 |
| 5.3 | 1.78 | 2.50 | 49.3 | 8.9 | 2.55 | 1.30 | A-242 |
| 4.8 | 1.79 | 2.47 | 44.3 | 8.0 | 2.56 | 1.30 | A-243 |
| 4.3 | 1.80 | 2.45 | 39.4 | 7.1 | 2.57 | 1.31 | A-650 |
| 2.6 | 0.90 | 2.66 | 40.8 | 9.4 | 2.20 | 0.74 | A-244 |
| 2.5 | 0.91 | 2.64 | 38.4 | 8.8 | 2.21 | 0.74 | A-245 |
| 2.3 | 0.91 | 2.62 | 36.0 | 8.2 | 2.22 | 0.74 | A-246 |
| 2.1 | 0.92 | 2.60 | 33.5 | 7.6 | 2.23 | 0.74 | A-247 |
| 2.0 | 0.93 | 2.57 | 30.9 | 7.0 | 2.24 | 0.75 | A-248 |
| 1.8 | 0.93 | 2.55 | 28.2 | 6.3 | 2.25 | 0.75 | A-249 |
| 1.6 | 0.94 | 2.53 | 25.4 | 5.7 | 2.25 | 0.75 | A-250 |
| 1.4 | 0.95 | 2.50 | 22.6 | 5.0 | 2.26 | 0.76 | A-251 |
| 1.2 | 0.96 | 2.48 | 19.8 | 4.3 | 2.26 | 0.77 | A-252 |
| 3.2 | 1.11 | 2.10 | 26.1 | 6.7 | 1.87 | 0.86 | A-258 |
| 3.0 | 1.12 | 2.08 | 24.5 | 6.2 | 1.88 | 0.86 | A-259 |
| 2.8 | 1.13 | 2.06 | 22.8 | 5.8 | 1.89 | 0.86 | A-260 |
| 2.5 | 1.13 | 2.03 | 21.1 | 5.3 | 1.90 | 0.86 | A-261 |
| 2.3 | 1.14 | 2.01 | 19.3 | 4.8 | 1.90 | 0.87 | A-262 |
| 2.1 | 1.15 | 1.99 | 17.4 | 4.3 | 1.91 | 0.87 | A-263 |
| 1.9 | 1.16 | 1.96 | 15.5 | 3.8 | 1.92 | 0.87 | A-264 |
| 1.6 | 1.17 | 1.94 | 13.5 | 3.3 | 1.93 | 0.88 | A-265 |

# Properties of Angles

## Unequal Legs

### Continued

| Section Index | Dimensions, Inches d x b | Thickness, Inches t | Weight per Foot, Pounds | Area of Section, Square Inches A | Distance of Center of Gravity from Back of Longer Leg, Inches n | Moment of Inertia, Axis Y—Y I |
|---|---|---|---|---|---|---|
| A-274 | 6 x 3½ | ¾ | 22.4 | 6.56 | 0.93 | 5.8 |
| A-275 | 6 x 3½ | 11/16 | 20.6 | 6.06 | 0.90 | 5.5 |
| A-276 | 6 x 3½ | ⅝ | 18.9 | 5.55 | 0.88 | 5.1 |
| A-277 | 6 x 3½ | 9/16 | 17.1 | 5.03 | 0.86 | 4.7 |
| A-278 | 6 x 3½ | ½ | 15.3 | 4.50 | 0.83 | 4.3 |
| A-279 | 6 x 3½ | 7/16 | 13.5 | 3.97 | 0.81 | 3.8 |
| A-280 | 6 x 3½ | ⅜ | 11.7 | 3.42 | 0.78 | 3.3 |
| A-286 | 5 x 4 | 13/16 | 22.7 | 6.65 | 1.18 | 8.7 |
| A-287 | 5 x 4 | ¾ | 21.1 | 6.19 | 1.16 | 8.2 |
| A-288 | 5 x 4 | 11/16 | 19.5 | 5.72 | 1.14 | 7.7 |
| A-289 | 5 x 4 | ⅝ | 17.8 | 5.23 | 1.12 | 7.1 |
| A-290 | 5 x 4 | 9/16 | 16.2 | 4.75 | 1.10 | 6.6 |
| A-291 | 5 x 4 | ½ | 14.5 | 4.25 | 1.07 | 6.0 |
| A-292 | 5 x 4 | 7/16 | 12.8 | 3.75 | 1.05 | 5.3 |
| A-293 | 5 x 4 | ⅜ | 11.0 | 3.23 | 1.03 | 4.7 |
| A-300 | 5 x 3½ | ¾ | 19.8 | 5.81 | 1.00 | 5.6 |
| A-301 | 5 x 3½ | 11/16 | 18.3 | 5.37 | 0.97 | 5.2 |
| A-302 | 5 x 3½ | ⅝ | 16.8 | 4.92 | 0.95 | 4.8 |
| A-303 | 5 x 3½ | 9/16 | 15.2 | 4.47 | 0.93 | 4.4 |
| A-304 | 5 x 3½ | ½ | 13.6 | 4.00 | 0.91 | 4.0 |
| A-305 | 5 x 3½ | 7/16 | 12.0 | 3.53 | 0.88 | 3.6 |
| A-306 | 5 x 3½ | ⅜ | 10.4 | 3.05 | 0.86 | 3.2 |
| A-307 | 5 x 3½ | 5/16 | 8.7 | 2.56 | 0.84 | 2.7 |
| A-315 | 5 x 3 | 11/16 | 17.1 | 5.03 | 0.82 | 3.3 |
| A-316 | 5 x 3 | ⅝ | 15.7 | 4.61 | 0.80 | 3.1 |
| A-317 | 5 x 3 | 9/16 | 14.3 | 4.18 | 0.77 | 2.8 |
| A-318 | 5 x 3 | ½ | 12.8 | 3.75 | 0.75 | 2.6 |
| A-319 | 5 x 3 | 7/16 | 11.3 | 3.31 | 0.73 | 2.3 |
| A-320 | 5 x 3 | ⅜ | 9.8 | 2.86 | 0.70 | 2.0 |
| A-321 | 5 x 3 | 5/16 | 8.2 | 2.40 | 0.68 | 1.8 |



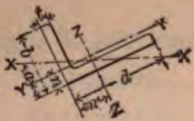
| Section Factor Axis Y—Y<br>S | Radius of Gyration Axis Y—Y, Inches<br>r | Distance of Center of Gravity from Back of Shorter Leg, Inches<br>n' | Moment of Inertia Axis Z—Z<br>I' | Section Factor Axis Z—Z<br>S' | Radius of Gyration Axis Z—Z<br>r' | Least Radius of Gyration Axis X—X, Inches<br>r" | Section Index |
|---|---|---|---|---|---|---|---|
| 2.3 | 0.94 | 2.18 | 23.3 | 6.1 | 1.89 | 0.75 | A-274 |
| 2.1 | 0.95 | 2.15 | 21.7 | 5.6 | 1.89 | 0.75 | A-275 |
| 1.9 | 0.96 | 2.13 | 20.1 | 5.2 | 1.90 | 0.75 | A-276 |
| 1.8 | 0.96 | 2.11 | 18.4 | 4.7 | 1.91 | 0.75 | A-277 |
| 1.6 | 0.97 | 2.08 | 16.6 | 4.2 | 1.92 | 0.76 | A-278 |
| 1.4 | 0.98 | 2.06 | 14.8 | 3.7 | 1.93 | 0.76 | A-279 |
| 1.2 | 0.99 | 2.04 | 12.9 | 3.3 | 1.94 | 0.77 | A-280 |
| 3.1 | 1.15 | 1.68 | 15.5 | 4.7 | 1.53 | 0.84 | A-286 |
| 2.9 | 1.15 | 1.66 | 14.6 | 4.4 | 1.54 | 0.84 | A-287 |
| 2.7 | 1.16 | 1.64 | 13.6 | 4.1 | 1.54 | 0.84 | A-288 |
| 2.5 | 1.17 | 1.62 | 12.6 | 3.7 | 1.55 | 0.84 | A-289 |
| 2.3 | 1.18 | 1.60 | 11.6 | 3.4 | 1.56 | 0.85 | A-290 |
| 2.0 | 1.18 | 1.57 | 10.5 | 3.1 | 1.57 | 0.85 | A-291 |
| 1.8 | 1.19 | 1.55 | 9.3 | 2.7 | 1.58 | 0.85 | A-292 |
| 1.6 | 1.20 | 1.53 | 8.1 | 2.3 | 1.59 | 0.86 | A-293 |
| 2.2 | 0.98 | 1.75 | 13.9 | 4.3 | 1.55 | 0.75 | A-300 |
| 2.1 | 0.98 | 1.72 | 13.0 | 4.0 | 1.56 | 0.75 | A-301 |
| 1.9 | 0.99 | 1.70 | 12.0 | 3.7 | 1.56 | 0.75 | A-302 |
| 1.7 | 1.00 | 1.68 | 11.0 | 3.3 | 1.57 | 0.75 | A-303 |
| 1.6 | 1.01 | 1.66 | 10.0 | 3.0 | 1.58 | 0.75 | A-304 |
| 1.4 | 1.01 | 1.63 | 8.9 | 2.6 | 1.59 | 0.76 | A-305 |
| 1.2 | 1.02 | 1.61 | 7.8 | 2.3 | 1.60 | 0.76 | A-306 |
| 1.0 | 1.03 | 1.59 | 6.6 | 1.9 | 1.61 | 0.76 | A-307 |
| 1.5 | 0.81 | 1.82 | 12.3 | 3.9 | 1.56 | 0.64 | A-315 |
| 1.4 | 0.81 | 1.80 | 11.4 | 3.5 | 1.57 | 0.64 | A-316 |
| 1.3 | 0.82 | 1.77 | 10.4 | 3.2 | 1.58 | 0.65 | A-317 |
| 1.1 | 0.83 | 1.75 | 9.5 | 2.9 | 1.59 | 0.65 | A-318 |
| 1.0 | 0.84 | 1.73 | 8.4 | 2.6 | 1.60 | 0.65 | A-319 |
| 0.89 | 0.84 | 1.70 | 7.4 | 2.2 | 1.61 | 0.65 | A-320 |
| 0.75 | 0.85 | 1.68 | 6.3 | 1.9 | 1.61 | 0.66 | A-321 |

# Properties of Angles

## Unequal Legs

### Continued

| Section Index | Dimensions, Inches d x b | Thickness, Inches t | Weight per Foot, Pounds | Area of Section, Square Inches A | Distance of Center of Gravity from Back of Longer Leg, Inches n | Moment of Inertia, Axis Y—Y I |
|---|---|---|---|---|---|---|
| A-328 | 4½x 3 | 11/16 | 16.0 | 4.68 | 0.85 | 3.2 |
| A-329 | 4½x 3 | ⅝ | 14.7 | 4.30 | 0.83 | 3.0 |
| A-330 | 4½x 3 | 9/16 | 13.3 | 3.90 | 0.81 | 2.8 |
| A-331 | 4½x 3 | ½ | 11.9 | 3.50 | 0.79 | 2.5 |
| A-332 | 4½x 3 | 7/16 | 10.6 | 3.09 | 0.76 | 2.3 |
| A-333 | 4½x 3 | ⅜ | 9.1 | 2.67 | 0.74 | 2.0 |
| A-334 | 4½x 3 | 5/16 | 7.7 | 2.25 | 0.72 | 1.7 |
| A-339 | 4 x3½ | 13/16 | 18.5 | 5.43 | 1.11 | 5.5 |
| A-340 | 4 x3½ | ¾ | 17.3 | 5.06 | 1.09 | 5.2 |
| A-341 | 4 x3½ | 11/16 | 16.0 | 4.68 | 1.07 | 4.9 |
| A-342 | 4 x3½ | ⅝ | 14.7 | 4.30 | 1.04 | 4.5 |
| A-343 | 4 x3½ | 9/16 | 13.3 | 3.90 | 1.02 | 4.2 |
| A-344 | 4 x3½ | ½ | 11.9 | 3.50 | 1.00 | 3.8 |
| A-345 | 4 x3½ | 7/16 | 10.6 | 3.09 | 0.98 | 3.4 |
| A-346 | 4 x3½ | ⅜ | 9.1 | 2.67 | 0.96 | 3.0 |
| A-347 | 4 x3½ | 5/16 | 7.7 | 2.25 | 0.93 | 2.6 |
| A-354 | 4 x 3 | 11/16 | 14.8 | 4.34 | 0.89 | 3.1 |
| A-355 | 4 x 3 | ⅝ | 13.6 | 3.98 | 0.87 | 2.9 |
| A-356 | 4 x 3 | 9/16 | 12.4 | 3.62 | 0.85 | 2.7 |
| A-357 | 4 x 3 | ½ | 11.1 | 3.25 | 0.83 | 2.4 |
| A-358 | 4 x 3 | 7/16 | 9.8 | 2.87 | 0.80 | 2.2 |
| A-359 | 4 x 3 | ⅜ | 8.5 | 2.48 | 0.78 | 1.9 |
| A-360 | 4 x 3 | 5/16 | 7.2 | 2.09 | 0.76 | 1.7 |
| A-361 | 4 x 3 | ¼ | 5.8 | 1.69 | 0.74 | 1.4 |
| A-365 | 3½x 3 | 11/16 | 13.6 | 4.00 | 0.94 | 3.0 |
| A-366 | 3½x 3 | ⅝ | 12.5 | 3.67 | 0.92 | 2.8 |
| A-367 | 3½x 3 | 9/16 | 11.4 | 3.34 | 0.90 | 2.5 |
| A-368 | 3½x 3 | ½ | 10.2 | 3.00 | 0.88 | 2.3 |
| A-369 | 3½x 3 | 7/16 | 9.1 | 2.65 | 0.85 | 2.1 |
| A-370 | 3½x 3 | ⅜ | 7.9 | 2.30 | 0.83 | 1.8 |
| A-371 | 3½x 3 | 5/16 | 6.6 | 1.93 | 0.81 | 1.6 |
| A-372 | 3½x 3 | ¼ | 5.4 | 1.56 | 0.79 | 1.3 |



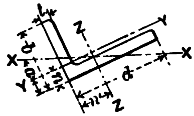
| ...ion ...tor ...is ...-Y | Radius of Gyration Axis Y—Y, Inches r | Distance of Center of Gravity from Back of Shorter Leg, Inches n′ | Moment of Inertia Axis Z—Z I′ | Section Factor Axis Z—Z S′ | Radius of Gyration Axis Z—Z r′ | Least Radius of Gyration Axis X—X, Inches r″ | Section Index |
|---|---|---|---|---|---|---|---|
| 5 | 0.83 | 1.60 | 9.1 | 3.1 | 1.39 | 0.64 | A-328 |
| 4 | 0.83 | 1.58 | 8.4 | 2.9 | 1.40 | 0.64 | A-329 |
| 3 | 0.85 | 1.56 | 7.8 | 2.6 | 1.41 | 0.64 | A-330 |
| 1 | 0.85 | 1.54 | 7.0 | 2.4 | 1.42 | 0.65 | A-331 |
| 0 | 0.85 | 1.51 | 6.3 | 2.1 | 1.43 | 0.65 | A-332 |
| 88 | 0.86 | 1.49 | 5.5 | 1.8 | 1.44 | 0.66 | A-333 |
| 75 | 0.87 | 1.47 | 4.7 | 1.5 | 1.44 | 0.66 | A-334 |
| | | | | | | | |
| 3 | 1.01 | 1.36 | 7.8 | 2.9 | 1.19 | 0.72 | A-339 |
| 1 | 1.01 | 1.34 | 7.3 | 2.8 | 1.20 | 0.72 | A-340 |
| 0 | 1.02 | 1.32 | 6.9 | 2.6 | 1.21 | 0.72 | A-341 |
| 8 | 1.03 | 1.29 | 6.4 | 2.4 | 1.22 | 0.72 | A-342 |
| 7 | 1.03 | 1.27 | 5.9 | 2.1 | 1.23 | 0.72 | A-343 |
| 5 | 1.04 | 1.25 | 5.3 | 1.9 | 1.23 | 0.72 | A-344 |
| 3 | 1.05 | 1.23 | 4.8 | 1.7 | 1.24 | 0.72 | A-345 |
| 2 | 1.06 | 1.21 | 4.2 | 1.5 | 1.25 | 0.73 | A-346 |
| 0 | 1.07 | 1.18 | 3.6 | 1.3 | 1.26 | 0.73 | A-347 |
| | | | | | | | |
| 5 | 0.84 | 1.39 | 6.5 | 2.5 | 1.22 | 0.64 | A-354 |
| 4 | 0.85 | 1.37 | 6.0 | 2.3 | 1.23 | 0.64 | A-355 |
| 2 | 0.86 | 1.35 | 5.6 | 2.1 | 1.24 | 0.64 | A-356 |
| 1 | 0.86 | 1.33 | 5.0 | 1.9 | 1.25 | 0.64 | A-357 |
| 0 | 0.87 | 1.30 | 4.5 | 1.7 | 1.25 | 0.64 | A-358 |
| 87 | 0.88 | 1.28 | 4.0 | 1.5 | 1.26 | 0.64 | A-359 |
| 74 | 0.89 | 1.26 | 3.4 | 1.2 | 1.27 | 0.65 | A-360 |
| 60 | 0.89 | 1.24 | 2.8 | 1.0 | 1.28 | 0.65 | A-361 |
| | | | | | | | |
| 4 | 0.86 | 1.19 | 4.4 | 1.9 | 1.05 | 0.62 | A-365 |
| 3 | 0.87 | 1.17 | 4.1 | 1.8 | 1.06 | 0.62 | A-366 |
| 2 | 0.87 | 1.15 | 3.8 | 1.6 | 1.07 | 0.62 | A-367 |
| 1 | 0.88 | 1.13 | 3.5 | 1.5 | 1.07 | 0.62 | A-368 |
| 98 | 0.89 | 1.10 | 3.1 | 1.3 | 1.08 | 0.62 | A-369 |
| 85 | 0.90 | 1.08 | 2.7 | 1.1 | 1.09 | 0.62 | A-370 |
| 72 | 0.90 | 1.06 | 2.3 | 0.96 | 1.10 | 0.63 | A-371 |
| 8 | 0.91 | 1.04 | 1.9 | 0.78 | 1.11 | 0.63 | A-372 |

# Properties of Angles

## Unequal Legs

### Continued

| Section Index | Dimensions, Inches<br>d x b | Thickness, Inches<br>t | Weight per Foot, Pounds | Area of Section, Square Inches<br>A | Distance of Center of Gravity from Back of Longer Leg, Inches<br>n | Moment of Inertia, Axis Y—Y<br>I |
|---|---|---|---|---|---|---|
| A-379 | 3½x2½ | $\frac{9}{16}$ | 10.4 | 3.06 | 0.73 | 1.5 |
| A-380 | 3½x2½ | ½ | 9.4 | 2.75 | 0.70 | 1.4 |
| A-381 | 3½x2½ | $\frac{7}{16}$ | 8.3 | 2.43 | 0.68 | 1.2 |
| A-382 | 3½x2½ | ⅜ | 7.2 | 2.11 | 0.66 | 1.1 |
| A-383 | 3½x2½ | $\frac{5}{16}$ | 6.1 | 1.78 | 0.64 | 0.94 |
| A-384 | 3½x2½ | ¼ | 4.9 | 1.44 | 0.61 | 0.78 |
| A-405 | 3 x2½ | $\frac{9}{16}$ | 9.5 | 2.78 | 0.77 | 1.4 |
| A-406 | 3 x2½ | ½ | 8.5 | 2.50 | 0.75 | 1.3 |
| A-407 | 3 x2½ | $\frac{7}{16}$ | 7.6 | 2.21 | 0.73 | 1.2 |
| A-408 | 3 x2½ | ⅜ | 6.6 | 1.92 | 0.71 | 1.0 |
| A-409 | 3 x2½ | $\frac{5}{16}$ | 5.6 | 1.62 | 0.68 | 0.90 |
| A-410 | 3 x2½ | ¼ | 4.5 | 1.31 | 0.66 | 0.74 |
| A-415 | 3 x 2 | ½ | 7.7 | 2.25 | 0.58 | 0.67 |
| A-416 | 3 x 2 | $\frac{7}{16}$ | 6.8 | 2.00 | 0.56 | 0.61 |
| A-417 | 3 x 2 | ⅜ | 5.9 | 1.73 | 0.54 | 0.54 |
| A-418 | 3 x 2 | $\frac{5}{16}$ | 5.0 | 1.47 | 0.52 | 0.47 |
| A-419 | 3 x 2 | ¼ | 4.1 | 1.19 | 0.49 | 0.39 |
| A-420 | 3 x 2 | $\frac{3}{16}$ | 3.07 | 0.91 | 0.47 | 0.31 |
| A-425 | 2½x 2 | ½ | 6.8 | 2.00 | 0.63 | 0.64 |
| A-426 | 2½x 2 | $\frac{7}{16}$ | 6.1 | 1.78 | 0.60 | 0.58 |
| A-427 | 2½x 2 | ⅜ | 5.3 | 1.55 | 0.58 | 0.51 |
| A-428 | 2½x 2 | $\frac{5}{16}$ | 4.5 | 1.31 | 0.56 | 0.45 |
| A-429 | 2½x 2 | ¼ | 3.62 | 1.06 | 0.54 | 0.37 |
| A-430 | 2½x 2 | $\frac{3}{16}$ | 2.75 | 0.81 | 0.51 | 0.29 |




| Section Factor Axis Y—Y S | Radius of Gyration Axis Y—Y, Inches r | Distance of Center of Gravity from Back of Shorter Leg, Inches n' | Moment of Inertia Axis Z—Z I' | Section Factor Axis Z—Z S' | Radius of Gyration Axis Z—Z r' | Least Radius of Gyration Axis X—X, Inches r" | Section Index |
|---|---|---|---|---|---|---|---|
| 0.84 | 0.70 | 1.23 | 3.6 | 1.6 | 1.08 | 0.53 | A-379 |
| 0.76 | 0.70 | 1.20 | 3.2 | 1.4 | 1.09 | 0.53 | A-380 |
| 0.68 | 0.71 | 1.18 | 2.9 | 1.3 | 1.09 | 0.54 | A-381 |
| 0.59 | 0.72 | 1.16 | 2.6 | 1.1 | 1.10 | 0.54 | A-382 |
| 0.50 | 0.73 | 1.14 | 2.2 | 0.93 | 1.11 | 0.54 | A-383 |
| 0.41 | 0.74 | 1.11 | 1.8 | 0.75 | 1.12 | 0.54 | A-384 |
| | | | | | | | |
| 0.82 | 0.72 | 1.02 | 2.3 | 1.2 | 0.91 | 0.52 | A-405 |
| 0.74 | 0.72 | 1.00 | 2.1 | 1.0 | 0.91 | 0.52 | A-406 |
| 0.66 | 0.73 | 0.98 | 1.9 | 0.93 | 0.92 | 0.52 | A-407 |
| 0.58 | 0.74 | 0.96 | 1.7 | 0.81 | 0.93 | 0.52 | A-408 |
| 0.49 | 0.74 | 0.93 | 1.4 | 0.69 | 0.94 | 0.53 | A-409 |
| 0.40 | 0.75 | 0.91 | 1.2 | 0.56 | 0.95 | 0.53 | A-410 |
| | | | | | | | |
| 0.47 | 0.55 | 1.08 | 1.9 | 1.00 | 0.92 | 0.43 | A-415 |
| 0.42 | 0.55 | 1.06 | 1.7 | 0.89 | 0.93 | 0.43 | A-416 |
| 0.37 | 0.56 | 1.04 | 1.5 | 0.78 | 0.94 | 0.43 | A-417 |
| 0.32 | 0.57 | 1.02 | 1.3 | 0.66 | 0.95 | 0.43 | A-418 |
| 0.25 | 0.57 | 0.99 | 1.1 | 0.54 | 0.95 | 0.43 | A-419 |
| 0.20 | 0.58 | 0.97 | 0.84 | 0.41 | 0.96 | 0.44 | A-420 |
| | | | | | | | |
| 0.46 | 0.56 | 0.88 | 1.1 | 0.70 | 0.75 | 0.42 | A-425 |
| 0.41 | 0.57 | 0.85 | 1.0 | 0.62 | 0.76 | 0.42 | A-426 |
| 0.36 | 0.58 | 0.83 | 0.91 | 0.55 | 0.77 | 0.42 | A-427 |
| 0.31 | 0.58 | 0.81 | 0.79 | 0.47 | 0.78 | 0.42 | A-428 |
| 0.25 | 0.59 | 0.79 | 0.65 | 0.38 | 0.78 | 0.42 | A-429 |
| 0.20 | 0.60 | 0.76 | 0.51 | 0.29 | 0.79 | 0.43 | A-430 |

## Properties of Tees

| Section Index | Size Flange by Stem, Inches | Weight per Foot, Pounds | Area of Section, Square Inches | Distance of Center of Gravity from Outside of Flange, Inches | Moment of Inertia Neutral Axis through Center of Gravity Parallel to Flange I | Least Section Factor, Neutral Axis through Center of Gravity Parallel to Flange S | Radius of Gyration, Neutral Axis through Center of Gravity Parallel to Flange r | Moment of Inertia, Neutral Axis through Center of Gravity Coincident with Center Line of Stem I′ | Section Factor, Neutral Axis through Center of Gravity Coincident with Center Line of Stem S′ | Radius of Gyration, Neutral Axis through Center of Gravity Coincident with Center Line of Stem r′ |
|---|---|---|---|---|---|---|---|---|---|---|
| T-3 | 4 x 4 | 13.5 | 3.97 | 1.178 | 5.715 | 2.025 | 1.2 | 2.8066 | 1.4033 | .841 |
| T-4 | 4 x 4 | 12.1 | 3.56 | 1.144 | 5.166 | 1.808 | 1.204 | 2.4586 | 1.2293 | .831 |
| T-9 | 3½x 3½ | 10.5 | 3.09 | 1.022 | 3.376 | 1.362 | 1.045 | 1.6540 | .945 | .731 |
| T-10 | 3½x 3½ | 9.2 | 2.70 | .9983 | 2.996 | 1.195 | 1.050 | 1.3928 | .796 | .716 |
| T-15 | 3 x 3 | 7.8 | 2.29 | .877 | 1.838 | .864 | .893 | .8918 | .599 | .625 |
| T-16 | 3 x 3 | 6.7 | 1.97 | .847 | 1.609 | .743 | .897 | .7520 | .501 | .617 |
| T-17 | 3 x 3 | 5.5 | 1.61 | .824 | 1.325 | .609 | .905 | .6066 | .404 | .611 |
| T-22 | 2½x 2½ | 6.4 | 1.88 | .756 | 1.022 | .585 | .737 | .5243 | .419 | .528 |
| T-23 | 2½x 2½ | 5.5 | 1.61 | .729 | .892 | .503 | .742 | .4386 | .3508 | .521 |
| T-28 | 2¼x 2¼ | 4.7 | 1.38 | .669 | .623 | .394 | .671 | .3109 | .2764 | .474 |
| T-29 | 2¼x 2¼ | 3.83 | 1.13 | .650 | .519 | .324 | .678 | .2488 | .2211 | .469 |
| T-33 | 2 x 2 | 4.1 | 1.20 | .613 | .4247 | .306 | .593 | .2194 | .2194 | .426 |
| T-34 | 2 x 2 | 3.38 | 1.00 | .588 | .3577 | .253 | .599 | .1754 | .1754 | .420 |

# Properties of Tees

**Continued**

| Section Index | Size Flange by Stem, Inches | Weight per Foot, Pounds | Area of Section, Square Inches | Distance of Center of Gravity from Outside of Flange, Inches | Moment of Inertia Neutral Axis through Center of Gravity Parallel to Flange I | Least Section Factor, Neutral Axis through Center of Gravity Parallel to Flange S | Radius of Gyration, Neutral Axis through Center of Gravity Parallel to Flange r | Moment of Inertia, Neutral Axis through Center of Gravity Coincident with Center Line of Stem I′ | Section Factor, Neutral Axis through Center of Gravity Coincident with Center Line of Stem S′ | Radius of Gyration, Neutral Axis through Center of Gravity Coincident with Center Line of Stem r′ |
|---|---|---|---|---|---|---|---|---|---|---|
| T-39 | 1¾x 1¾ | 2.93 | .86 | .526 | .2315 | .189 | .518 | .1181 | .1349 | .370 |
| T-40 | 1¾x 1¾ | 2.28 | .67 | .503 | .1857 | .148 | .526 | .0887 | .1013 | .346 |
| T-45 | 1½x 1½ | 2.47 | .72 | .47 | .15 | .14 | .45 | .08 | .10 | .32 |
| T-46 | 1½x 1½ | 1.94 | .57 | .44 | .11 | .11 | .45 | .06 | .08 | .32 |
| T-51 | 1¼x 1¼ | 2.02 | .59 | .40 | .08 | .10 | .37 | .05 | .07 | .28 |
| T-52 | 1¼x 1¼ | 1.59 | .47 | .38 | .06 | .07 | .37 | .03 | .05 | .27 |
| T-57 | 1 x 1 | 1.25 | .37 | .32 | .03 | .05 | .29 | .02 | .04 | .22 |
| T-58 | 1 x 1 | 0.89 | .26 | .29 | .02 | .03 | .30 | .01 | .02 | .21 |
| *T-69 | 5 x 2½ | 10.9 | 3.2 | .63 | 1.5 | .78 | .68 | 4.1 | 1.6 | 1.14 |
| *T-74 | 4½x 3 | 8.4 | 2.47 | .71 | 1.8 | .78 | .85 | 2.5 | 1.1 | 1.01 |
| T-79 | 4 x 2 | 7.8 | 2.29 | .48 | .60 | .40 | .52 | 2.1 | 1.1 | .96 |
| T-80 | 4 x 2 | 6.7 | 1.97 | .46 | .53 | .34 | .52 | 1.8 | .88 | .95 |

*Made only by special arrangement.

## Properties of Tees

Continued

| Section Index | Size Flange by Stem, Inches | Weight per Foot, Pounds | Area of Section, Square Inches | Distance of Center of Gravity from Outside of Flange, Inches | Moment of Inertia Neutral Axis through Center of Gravity Parallel to Flange I | Least Section Factor, Neutral Axis through Center of Gravity Parallel to Flange S | Radius of Gyration, Neutral Axis through Center of Gravity Parallel to Flange r | Moment of Inertia, Neutral Axis through Center of Gravity Coincident with Center Line of Stem I′ | Section Factor, Neutral Axis through Center of Gravity Coincident with Center Line of Stem S′ | Radius of Gyration, Neutral Axis through Center of Gravity Coincident with Center Line of Stem r′ |
|---|---|---|---|---|---|---|---|---|---|---|
| T-85 | 3½x 4 | 12.6 | 3.70 | 1.24 | 5.5 | 2.0 | 1.21 | 1.9 | 1.1 | .72 |
| T-86 | 3½x 4 | 9.8 | 2.88 | 1.19 | 4.3 | 1.5 | 1.23 | 1.4 | .81 | .70 |
| T-91 | 3½x 3 | 9.7 | 2.85 | .845 | 2.1667 | 1.005 | .8719 | 1.649 | .942 | .760 |
| T-92 | 3½x 3 | 8.5 | 2.50 | .83 | 1.9 | .89 | .88 | 1.4 | .81 | .75 |
| T-96 | 3 x 3½ | 10.8 | 3.17 | 1.12 | 3.5 | 1.5 | 1.06 | 1.2 | .80 | .62 |
| T-97 | 3 x 3½ | 9.7 | 2.85 | 1.10 | 3.2 | 1.3 | 1.06 | 1.0 | .69 | .61 |
| T-98 | 3 x 3½ | 8.5 | 2.50 | 1.07 | 2.8 | 1.2 | 1.07 | .93 | .62 | .60 |
| T-103 | 2½x 2 | 4.7 | 1.38 | .554 | .4576 | .316 | .575 | .4234 | .3387 | .5535 |
| T-108 | 2½x 1¾ | 3.6 | 1.06 | .4529 | .2596 | .2000 | .494 | .3392 | .271 | .565 |
| T-112 | 2$\frac{1}{32}$x 2¼ | 3.65 | 1.07 | .6507 | .4678 | .2902 | .661 | .1775 | .1747 | .407 |

# Properties of Zees

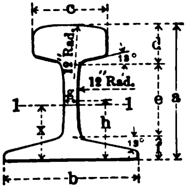
| Section Index | Depth of Web, Inches | Width of Flange, Inches | Thickness of Metal, Inches | Weight per Foot, Pounds | Area of Section, Square Inches | Moments of Inertia | | Section Factors | | Radii of Gyration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | I | I′ | S | S′ | r | r′ | $r^2$ |
| | | | | | | Neutral Axis through Center of Gravity Perpendicular to Web | Neutral Axis through Center of Gravity Coincident with Web | Neutral Axis Through Center of Gravity Perpendicular to Web | Neutral Axis Through Center of Gravity Coincident with Web | Neutral Axis Through Center of Gravity Perpendicular to Web | Neutral Axis Through Center of Gravity Coincident with Web | Least Radius Neutral Axis Diagonal |
| Z-70 | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{13}{16}$ | 28.4 | 8.33 | 28.7 | 14.4 | 11.2 | 4.8 | 1.86 | 1.31 | 0.76 |
| Z-71 | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{3}{4}$ | 26.0 | 7.64 | 26.2 | 12.8 | 10.3 | 4.4 | 1.85 | 1.30 | 0.74 |
| Z-72 | 5 | $3\frac{1}{4}$ | $\frac{11}{16}$ | 23.7 | 6.96 | 23.7 | 11.4 | 9.5 | 3.9 | 1.84 | 1.28 | 0.73 |
| Z-73 | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{5}{8}$ | 22.6 | 6.64 | 24.5 | 12.1 | 9.6 | 3.9 | 1.92 | 1.35 | 0.76 |
| Z-74 | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{9}{16}$ | 20.2 | 5.94 | 21.8 | 10.5 | 8.6 | 3.5 | 1.91 | 1.33 | 0.75 |
| Z-75 | 5 | $3\frac{1}{4}$ | $\frac{1}{2}$ | 17.9 | 5.25 | 19.2 | 9.1 | 7.7 | 3.0 | 1.91 | 1.31 | 0.74 |
| Z-76 | $5\frac{1}{8}$ | $3\frac{3}{8}$ | $\frac{7}{16}$ | 16.4 | 4.81 | 19.1 | 9.2 | 7.4 | 2.9 | 1.99 | 1.38 | 0.77 |
| Z-77 | $5\frac{1}{16}$ | $3\frac{5}{16}$ | $\frac{3}{8}$ | 14.0 | 4.10 | 16.2 | 7.7 | 6.4 | 2.5 | 1.99 | 1.37 | 0.76 |
| Z-78 | 5 | $3\frac{1}{4}$ | $\frac{5}{16}$ | 11.6 | 3.40 | 13.4 | 6.2 | 5.3 | 2.0 | 1.98 | 1.35 | 0.75 |
| Z-80 | $4\frac{1}{8}$ | $3\frac{3}{16}$ | $\frac{3}{4}$ | 23.0 | 6.75 | 15.0 | 11.2 | 7.3 | 4.0 | 1.49 | 1.29 | 0.68 |
| Z-81 | $4\frac{1}{16}$ | $3\frac{1}{8}$ | $\frac{11}{16}$ | 20.9 | 6.14 | 13.5 | 10.0 | 6.7 | 3.6 | 1.48 | 1.27 | 0.67 |
| Z-82 | 4 | $3\frac{1}{16}$ | $\frac{5}{8}$ | 18.9 | 5.55 | 12.1 | 8.7 | 6.1 | 3.2 | 1.48 | 1.25 | 0.66 |
| Z-83 | $4\frac{1}{8}$ | $3\frac{3}{16}$ | $\frac{9}{16}$ | 18.0 | 5.27 | 12.7 | 9.3 | 6.2 | 3.2 | 1.55 | 1.33 | 0.68 |
| Z-84 | $4\frac{1}{16}$ | $3\frac{1}{8}$ | $\frac{1}{2}$ | 15.9 | 4.66 | 11.2 | 8.0 | 5.5 | 2.8 | 1.55 | 1.31 | 0.67 |
| Z-85 | 4 | $3\frac{1}{16}$ | $\frac{7}{16}$ | 13.8 | 4.05 | 9.7 | 6.7 | 4.8 | 2.4 | 1.55 | 1.29 | 0.66 |

# Properties of Zees

**Continued**

| Section Index | Depth of Web, Inches | Width of Flange, Inches | Thickness of Metal, Inches | Weight per Foot, Pounds | Area of Section, Square Inches | Moments of Inertia I: Neutral Axis through Center of Gravity Perpendicular to Web | Moments of Inertia I′: Neutral Axis through Center of Gravity Coincident with Web | Section Factors S: Neutral Axis Through Center of Gravity Perpendicular to Web | Section Factors S′: Neutral Axis Through Center of Gravity Coincident with Web | Radii of Gyration r: Neutral Axis Through Center of Gravity Perpendicular to Web | Radii of Gyration r′: Neutral Axis Through Center of Gravity Coincident with Web | Radii of Gyration r²: Least Radius Neutral Axis Diagonal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z-86 | 4 1/8 | 3 3/16 | 3/8 | 12.5 | 3.66 | 9.6 | 6.8 | 4.7 | 2.3 | 1.62 | 1.36 | 0.69 |
| Z-87 | 4 1/16 | 3 1/8 | 5/16 | 10.3 | 3.03 | 7.9 | 5.5 | 3.9 | 1.8 | 1.62 | 1.34 | 0.68 |
| Z-88 | 4 | 3 1/16 | 1/4 | 8.2 | 2.41 | 6.3 | 4.2 | 3.1 | 1.4 | 1.62 | 1.33 | 0.67 |
| Z-3 | 3 1/16 | 2 3/4 | 9/16 | 14.3 | 4.18 | 5.3 | 5.7 | 3.4 | 2.3 | 1.12 | 1.17 | 0.54 |
| Z-4 | 3 | 2 11/16 | 1/2 | 12.6 | 3.69 | 4.6 | 4.9 | 3.1 | 2.0 | 1.12 | 1.15 | 0.53 |
| Z-7 | 3 1/16 | 2 3/4 | 7/16 | 11.5 | 3.36 | 4.6 | 4.8 | 3.0 | 1.9 | 1.17 | 1.19 | 0.55 |
| Z-8 | 3 | 2 11/16 | 3/8 | 9.8 | 2.86 | 3.9 | 3.9 | 2.6 | 1.6 | 1.16 | 1.17 | 0.54 |
| Z-11 | 3 1/16 | 2 3/4 | 5/16 | 8.5 | 2.48 | 3.6 | 3.6 | 2.4 | 1.4 | 1.21 | 1.21 | 0.56 |
| Z-12 | 3 | 2 11/16 | 1/4 | 6.7 | 1.97 | 2.9 | 2.8 | 1.9 | 1.1 | 1.21 | 1.19 | 0.55 |
| Z-18 | 3 | 1 1/2 | 3/16 | 3.59 | 1.06 | 1.396 | .35 | .933 | .248 | 1.149 | .574 | .358 |

# Properties of A. S. C. E. and Light Rails

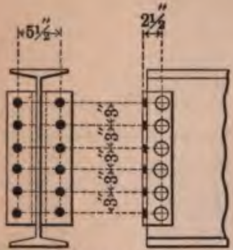



| Section Index | Weight per Yard | Area of Section | Dimensions | | | | | | | | Axis 1—1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | a | b | c | d | e | f | g | h | I | r | S | x |
| | Pounds | Sq. In. | In. | In. | In. | In. | In. | In. | In. | In. | | In. | | In. |
| .... | 110 | 10.80 | 6⅛ | 6⅛ | 2⅞ | 1 25/32 | 3 11/32 | 1 | 37/64 | 2 43/64 | 55.2 | 2.26 | 17.2 | 2.92 |
| .... | 100 | 9.84 | 5¾ | 5¾ | 2¾ | 1 45/64 | 3 5/64 | 31/32 | 9/16 | 2 65/128 | 44.0 | 2.11 | 14.6 | 2.73 |
| .... | 95 | 9.28 | 5 9/16 | 5 9/16 | 2 11/16 | 1 41/64 | 2 61/64 | 15/16 | 9/16 | 2 55/128 | 38.8 | 2.05 | 13.3 | 2.65 |
| .... | 90 | 8.83 | 5⅜ | 5⅜ | 2⅝ | 1 19/32 | 2 55/64 | 57/64 | 9/16 | 2 45/128 | 34.4 | 1.97 | 12.2 | 2.55 |
| .... | 85 | 8.33 | 5 3/16 | 5 3/16 | 2 9/16 | 1 35/64 | 2¾ | 55/64 | 9/16 | 2 17/64 | 30.1 | 1.90 | 11.1 | 2.47 |
| .... | 80 | 7.86 | 5 | 5 | 2½ | 1½ | 2⅝ | ⅞ | 35/64 | 2 3/16 | 26.4 | 1.83 | 10.1 | 2.38 |
| .... | 75 | 7.33 | 4 13/16 | 4 13/16 | 2 15/32 | 1 27/64 | 2 35/64 | 27/32 | 17/32 | 2 15/128 | 22.9 | 1.77 | 9.1 | 2.30 |
| .... | 70 | 6.81 | 4⅝ | 4⅝ | 2 7/16 | 1 11/32 | 2 15/32 | 13/16 | 33/64 | 2 3/64 | 19.7 | 1.70 | 8.2 | 2.22 |
| .... | 65 | 6.33 | 4 7/16 | 4 7/16 | 2 13/32 | 1 9/32 | 2⅜ | 25/32 | ½ | 1 31/32 | 16.9 | 1.63 | 7.4 | 2.14 |
| .... | 60 | 5.93 | 4¼ | 4¼ | 2⅜ | 1 7/32 | 2 17/64 | 49/64 | 31/64 | 1 115/128 | 14.6 | 1.57 | 6.6 | 2.05 |
| .... | 55 | 5.38 | 4 1/16 | 4 1/16 | 2¼ | 1 11/64 | 2 11/64 | 23/32 | 15/32 | 1 103/128 | 12.0 | 1.50 | 5.7 | 1.97 |
| .... | 50 | 4.87 | 3⅞ | 3⅞ | 2⅛ | 1⅛ | 2 1/16 | 11/16 | 7/16 | 1 23/32 | 9.9 | 1.43 | 5.0 | 1.88 |
| .... | 45 | 4.40 | 3 11/16 | 3 11/16 | 2 | 1 1/16 | 1 31/32 | 21/32 | 27/64 | 1 41/64 | 8.1 | 1.36 | 4.3 | 1.78 |
| R-40 | 40 | 3.94 | 3½ | 3½ | 1⅞ | 1 1/64 | 1 55/64 | ⅝ | 25/64 | 1 71/128 | 6.6 | 1.29 | 3.6 | 1.68 |
| R-35 | 35 | 3.44 | 3 5/16 | 3 5/16 | 1¾ | 61/64 | 1 23/32 | 37/64 | 23/64 | 1 15/32 | 5.2 | 1.23 | 3.0 | 1.60 |
| R-30 | 30 | 3.00 | 3⅛ | 3⅛ | 1 11/16 | ⅞ | 1 21/32 | 17/32 | 21/64 | 1 23/64 | 4.1 | 1.16 | 2.5 | 1.52 |
| R-25 | 25 | 2.39 | 2¾ | 2¾ | 1½ | 25/32 | 1 31/64 | 31/64 | 19/64 | 1 29/128 | 2.5 | 1.02 | 1.8 | 1.33 |
| R-20 | 20 | 2.00 | 2⅝ | 2⅝ | 1 11/32 | 23/32 | 1 15/32 | 7/16 | ¼ | 1 11/64 | 1.9 | 0.99 | 1.4 | 1.27 |
| R-16 | 16 | 1.55 | 2⅜ | 2⅜ | 1 11/64 | 41/64 | 1 23/64 | ⅜ | 7/32 | 1 7/128 | 1.2 | 0.89 | 1.0 | 1.15 |
| .... | 14 | 1.34 | 2 1/16 | 2 1/16 | 1 1/16 | ⅝ | 1 3/32 | 11/32 | ¼ | 61/64 | 0.76 | 0.75 | 0.73 | 1.02 |
| R-12 | 12 | 1.18 | 2 | 2 | 1 | 9/16 | 1 1/32 | 11/32 | 3/16 | 57/64 | 0.66 | 0.75 | 0.63 | 0.96 |
| .... | 10 | 0.96 | 1¾ | 1¾ | 15/16 | 31/64 | 15/16 | 19/64 | 3/16 | 49/64 | 0.40 | 0.65 | 0.46 | 0.87 |
| R-8 | 8 | 0.77 | 1 9/16 | 1 9/16 | 13/16 | 15/32 | 13/16 | 9/32 | 5/32 | 11/16 | 0.26 | 0.58 | 0.32 | 0.75 |

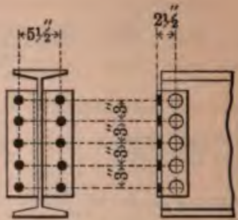
**Only sections carrying Index Numbers made by Jones & Laughlin Steel Company.**

# Beam and Channel Connections

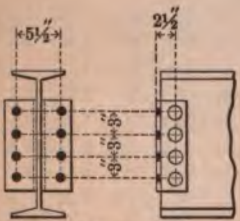
## All Rivets ¾″ Diameter



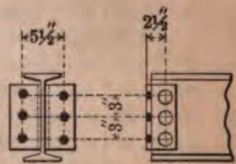

**24″** 2-4″ x 4″ x ½″ Angles-1′-5½″



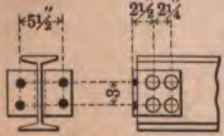

**20′-18″** 2-4″ x 4″x ½″ Angles-1′-2½″



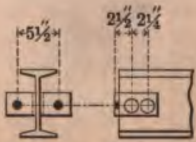

**15″** 2-4″x 4″x $\frac{7}{16}$″ Angles-0′-11½″



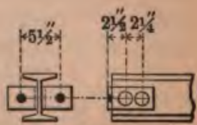

**12″** 2-4″ x 4 ″ x $\frac{7}{16}$″ Angles′-0-8½″




**10′-9′-8′**
2-6″ x 4″ x ⅜″ Angles-0′-5½″



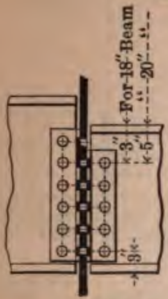

**7′-6′-5′**
2-6″ x 4″ x ⅜″ Angles-0′-3″



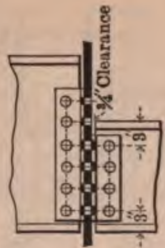

**4′-3′**
2-6″ x 4″ x ⅜″ Angles-0′-2″

# Location of Connection Angles

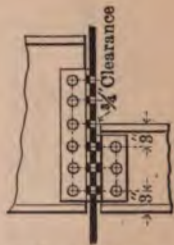
## For Different Depths of Beams Framing Opposite Bottoms or Tops Being Flush



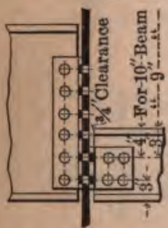

24″ Beam to { 18″ Beam / 20″ Beam



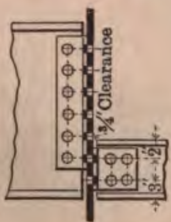

24″ Beam to 15″ Beam



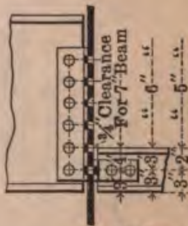

24″ Beam to 12″ Beam



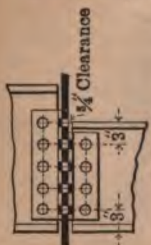

24″ Beam to { 10″ Beam / 9″ Beam



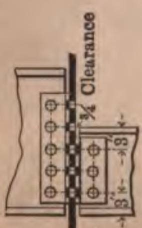

24″ Beam to 8″ Beam



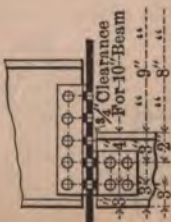

24″ Beam to { 7″ Beam / 6″ Beam / 5″ Beam



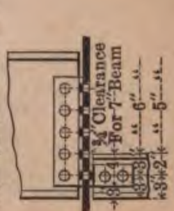

18″ / 20″ } to 15″ Beam




18″ / 20″ } to 12″ Beam



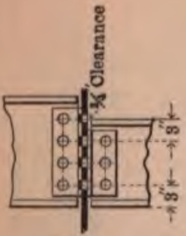

18″ / 20″ } to { 9″ Beam / 10″ Beam / 8″ Beam



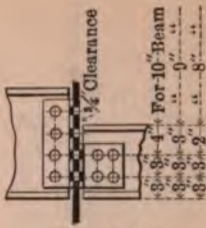

18″ / 20″ } to { 7″ Beam / 6″ Beam / 5″ Beam

# Location of Connection Angles

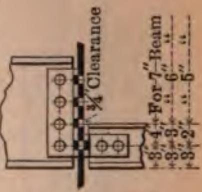
## For Different Depths of Beams Framing Opposite Bottoms or Tops Being Flush



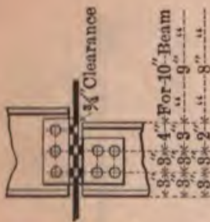

15″ Beam to 12″ Beam



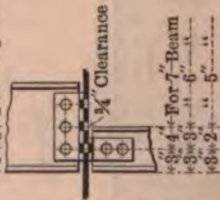

15″ Beam to { 10″ Beam<br>9″ Beam<br>8″ Beam



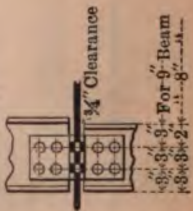

15″ Beam to { 7″ Beam<br>6″ Beam<br>5″ Beam



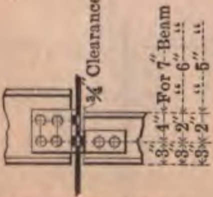

12″ Beam to { 10″ Beam<br>9″ Beam<br>8″ Beam



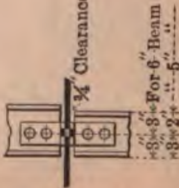

12″ Beam to { 7″ Beam<br>6″ Beam<br>5″ Beam




10″ Beam to { 9″ Beam<br>8″ Beam




10″ Beam, 9″ Beam, 8″ Beam } to { 7″ Beam<br>6″ Beam<br>5″ Beam




7″ Beam to { 6″ Beam<br>5″ Beam

# Limiting Values of Beam Connections

| I-Beams | | Value of Web Connection | Values of Outstanding Legs of Connection Angles | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Field Rivets | | | Field Bolts | | |
| Depth, Inches | Weight per Foot, Pounds | Shop Rivets in Enclosed Bearing, Pounds | ¾" Rivets or Turned Bolts, Single Shear, Pounds | Minimum Allowable Span, Uniform Load, Feet | *t*, In. | ¾" Rough Bolts, Single Shear, Pounds | Minimum Allowable Span, Uniform Load, Feet | *t*, In. |
| 24 | 80 | 67,500 | 53,000 | 17.5 | ⅝ | 42,400 | 21.9 | ⅝ |
| 20 | 65 | 56,200 | 44,200 | 14.2 | ⅝ | 35,300 | 17.6 | ⅝ |
| 18 | 55 | 51,800 | 44,200 | 10.7 | ⅝ | 35,300 | 13.4 | ⅝ |
| 15 | 42 | 36,900 | 35,300 | 8.9 | ⅝ | 28,300 | 11.2 | ⅝ |
| 12 | 31½ | 23,600 | 26,500 | 7.1 | $\frac{9}{16}$ | 21,200 | 9.0 | ⅝ |
| 10 | 25 | 27,900 | 17,700 | 7.4 | ⅝ | 14,100 | 9.2 | ⅝ |
| 9 | 21 | 26,100 | 17,700 | 5.7 | ⅝ | 14,100 | 7.1 | ⅝ |
| 8 | 18 | 24,300 | 17,700 | 4.3 | ⅝ | 14,100 | 5.4 | ⅝ |
| 7 | 15 | 11,300 | 8,800 | 6.2 | ⅝ | 7,100 | 7.8 | ⅝ |
| 6 | 12¼ | 10,400 | 8,800 | 4.4 | ⅝ | 7,100 | 5.5 | ⅝ |
| 5 | 9¾ | 9,500 | 8,800 | 2.9 | ⅝ | 7,100 | 3.6 | ⅝ |

# Allowable Unit Stress in Pounds per Square Inch

| Single Shear | | Bearing | |
|---|---|---|---|
| Rivets | Shop 12,000 | Rivets—enclosed | Shop 30,000 |
| Rivets and Turned Bolts | Field 16,000 | Rivets—one side | Shop 24,000 |
| Rough Bolts | Field 8,000 | Rivets and Turned Bolts | Field 20,000 |
| | | Rough Bolts | Field 16,000 |

*t*—Web Thickness, in bearing to develop maximum allowable reactions, when beams frame opposite.

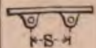
Connections are figured for bearing and shear (no moment considered).

The above values agree with tests made on beams under ordinary conditions of use.

Special connections should be used when any of the limiting conditions given above are exceeded such as end reactions from loaded beam being greater than value of connection; shorter span with beam fully loaded; or a less thickness of web when maximum allowable reactions are used.

# Cast Separators for Beams

## Separators with Two Bolts

| Designation of Beam | | Distances | | Bolts | | | Weights | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth, Inches | Weight, Pounds | Out to Out of Beam Flanges, Inches | Center to Center of Beams, Inches | Size, Inches |  Spacing, Inches S | Length for Minimum Width Separator, Inches | Bolts and Nuts, Pounds | Add to Bolts for Each Inch Additional Spread of Beams, Pounds | Separator, Pounds | Add to Separator for Each Inch Additional Spread of Beams, Pounds |
| 24 | 105 | 16½ | 8⅝ | ¾ | 12 | 10¼ | 3¾ | 0.25 | 35 | 4¼ |
| 24 | 80 | 14¾ | 7¾ | ¾ | 12 | 9¼ | 3½ | 0.25 | 32 | 4¼ |
| 20 | 80 | 14¾ | 7¾ | ¾ | 10 | 9¼ | 3½ | 0.25 | 28 | 3⅛ |
| 20 | 65 | 13¼ | 7 | ¾ | 10 | 8½ | 3¼ | 0.25 | 25 | 3⅛ |
| 18 | 55 | 12¾ | 6¾ | ¾ | 9 | 8½ | 3¼ | 0.25 | 16 | 2¾ |
| 15 | 60 | 12¾ | 6¾ | ¾ | 7 | 8½ | 3¼ | 0.25 | 15 | 1¾ |
| 15 | 42 | 11¾ | 6¼ | ¾ | 7 | 7¾ | 3 | 0.25 | 15 | 1¾ |
| 12 | 40 | 11¼ | 6 | ¾ | 6½ | 7½ | 3 | 0.25 | 11 | 1½ |
| 12 | 31½ | 10¾ | 5¾ | ¾ | 6½ | 7¼ | 3 | 0.25 | 11 | 1½ |

Separators for 18", 20" and 24" beams are made of ⅝" metal.
Separators for 6" to 15" beams are made of ½" metal.
Minimum widths given. Separators can be made wider.

# Cast Separators for Beams

## Separators with One Bolt

| Designation of Beam | | Distances | | Bolts | | | Weights | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth, Inches | Weight, Pounds | Out to Out of Beam Flanges, Inches | Center to Center of Beams, Inches | Size, Inches | Spacing, Inches S | Length for Minimum Width Separator, Inches | Bolts and Nuts, Pounds | Add to Bolts for Each Inch Additional Spread of Beams, Pounds | Separator, Pounds | Add to Separator for Each Inch Additional Spread of Beams, Pounds |
| 12 | 40 | 11¼ | 6 | ¾ | ... | 7½ | 1½ | 0.12 | 10 | 1½ |
| 12 | 31½ | 10¾ | 5¾ | ¾ | ... | 7¼ | 1½ | 0.12 | 10 | 1½ |
| 10 | 25 | 10¼ | 5⅝ | ¾ | ... | 7 | 1½ | 0.12 | 8 | 1¼ |
| 9 | 21 | 9⅜ | 5 | ¾ | ... | 6¼ | 1⅜ | 0.12 | 7 | 1¼ |
| 8 | 18 | 8¾ | 4¾ | ¾ | ... | 6 | 1¼ | 0.12 | 6 | 1 |
| 7 | 15 | 8¼ | 4½ | ¾ | ... | 5¾ | 1¼ | 0.12 | 4½ | ¾ |
| 6 | 12¼ | 7⅛ | 3¾ | ¾ | ... | 5 | 1¼ | 0.12 | 4 | ⅝ |
| 5 | 9¾ | 6½ | 3½ | ¾ | ... | 4¾ | 1⅛ | 0.12 | 3 | ½ |
| 4 | 7½ | 5⅞ | 3¼ | ¾ | ... | 4½ | 1⅛ | 0.12 | 3 | ⅜ |
| 3 | 5½ | 5¼ | 3 | ¾ | ... | 4 | 1 | 0.12 | 2 | ¼ |

Separators for 6" to 15" beams are made of ½" metal.
Separators for 5" beams and under are made of ⅜" metal.
Minimum widths given. Separators can be made wider.

## Standard Bearing Plates

### For Beams and Channels Resting on Good Brick Work Laid in Cement Mortar or High Class Concrete

| Depth of Beam or Channel, Inches | Bearing on Wall, Inches | Size of Bearing Plates, Inches | Weight of Bearing Plate, Pounds | Safe Load on Bearing Plates, Tons |
|---|---|---|---|---|
| 6 and less | 6 | 6 x 6 x 3/8 | 4 | 3.6 |
| 7 and 8 | 8 | 8 x 8 x 1/2 | 9 | 6.4 |
| 9 and 10 | 8 | 8 x 12 x 1/2 | 20 | 9.6 |
| 12 | 12 | 12 x 12 x 3/4 | 31 | 14.4 |
| 15 | 12 | 12 x 16 x 3/4 | 41 | 19.2 |
| 18 | 16 | 16 x 16 x 1 | 73 | 25.6 |
| 20 | 16 | 16 x 16 x 1 | 73 | 25.6 |
| 24 | 16 | 16 x 16 x 1 | 73 | 25.6 |

Bearing plates are used under the ends of steel beams and channels resting on walls to distribute the pressure on the latter, and must be of sufficient size so that the allowable safe pressure on the wall will not be exceeded.

Beams and girders having greater end reactions than the safe loads given in the above table will require plates of increased size. In such cases the sizes of bearing plates must be determined by the kind of masonry upon which the beams rest; the thickness to be obtained by the following formula:

$t = \frac{1}{2}(w-b)\sqrt{\frac{3p}{s}}$, in which

$t$ = thickness of plate, in inches.
$w$ = width of plate perpendicular to beam, in inches.
$b$ = width of flange of beam or channel, in inches.
$p$ = allowable pressure on wall, in pounds per square inch.
$s$ = allowable fiber stress in plate, in pounds per square inch.

The maximum allowable pressure on the different kinds of masonry is as follows:

Brick work laid in lime mortar....100 pounds per square inch
Brick work laid in cement mortar..200 pounds per square inch
*Good stone work*..................250 pounds per square inch
*Portland cement concrete*.........200 pounds per square inch

## Loads on Beams

The determination of the proper size of a rolled beam to use at some given point in a structure is probably the most common task of the designer of structural steel. To determine this it is necessary to know, first, the amount of the loads to which the beam will be subject; second, the character of the loads; and third, the ability of the metal in the beams to resist such loads.

In addition to the above, there will frequently arise a fourth factor to influence the decision, and that is the deformation of the beam under the loading, and the conditions of use, for no beam is or can be perfectly rigid, and the deflection or distortion of the beam under stress can readily be so great as to make the use of a given section inadvisable.

In order to produce static equilibrium, it is necessary in every case that the load on any beam be resisted by corresponding forces acting at the points of support known as the reactions. In the case of a simple beam, uniformly loaded and supported at the ends, the reaction at each end of the beam would be equal to one-half of the load. Where the load is not uniformly distributed then the reactions will vary directly as the intensity of the loading, but in all cases the sum of the reactions will equal the total load to be carried.

As a result of the loads and the accompanying reactions on the beam, there are created forces in the beam tending to shear or cut the beam across in a direction at right angles to its axis. These stresses are known as shearing stresses, and the shear at either support is always equal to the reaction at that support; the shear at any intermediate point in a beam between the supports is always equal to the reaction at the support minus the total load coming on the beam between that support and the point at which it is desired to ascertain the shear.

In the case of the above mentioned simple beam, resting on two supports and carrying a uniform load, the shear or reaction at each support is equal to one-half of the total load on the beam, and the shear decreases uniformly to zero at the center of the span. In the case of a beam loaded with a concentrated load at the center of the span, the reaction at the points of support will also be one-half of the total load. The shear, however, will not decrease towards the center but will remain uniform throughout the entire length of the beam, and would amount to one-half of the total load.

Another effect in the beam, due to the loading and its supporting reaction, is the creation of certain bending stresses in the beam. Taking any point in the length of the beam there will be found

## Loads on Beams

**Continued**

certain moments due to the loading, and certain counter moments due to the reactions; and the difference between these moments will be the measure of the strength that will have to be supplied by the beam in order that the structure may be in static equilibrium.

This bending moment varies for different points in the length of the beam, and attains a maximum value at that point where the shear mentioned above either becomes zero or changes its sign from positive to negative or from negative to positive.

In the case of a uniformly loaded beam, the point of maximum moment will be at the center of the span, as is also the case of a beam carrying a concentrated load at the center. Where loads are concentrated at several points, the maximum bending moment will always be found at the point of application of one of the loads, the particular load being that which is so located that the sum of all the loads coming on the beam between one of the supports up to and including that load is equal to or greater than the reaction of that support.

The stress in a beam caused by these bending moments, produces flexure in the beam, and the deflection, or the amount of departure of the beam from its unloaded position, is the measure of the deformation which the beam has undergone in its resistance to the bending stresses. This deformation should always be considered as it can readily be a sufficient amount to cause serious difficulties with other materials or other parts of the structure that are dependent on the beam under consideration for their support.

In calculations made for determining the sizes of beams, the loads are usually expressed in pounds, the length of the span and the distance between loads in feet and tenths of a foot, and the resulting bending moments in terms of foot pounds. This promotes convenience in handling figures, although it is necessary to convert these foot pounds into inch pounds before consulting tables of properties for the selection of the desired section.

The section modulus of the desired section is readily obtained by dividing the maximum bending moment, expressed in inch pounds, by the maximum allowed stress in the extreme fiber of the section, as expressed in pounds per square inch. Care should always be taken, however, in such cases to see that the neutral axis of the section is perpendicular to the line of action of the load. Should this not be the case careful investigation should be made so that due provision for the eccentricity of the loading can be made.

# Explanation of Tables of Structural Sections Used as Beams

The tables on pages 147 to 166 give the safe loads of beams, channels, angles, tees, and zees when used under a uniformly distributed transverse load. These loads are expressed in thousands of pounds for the more usual spans and are based upon the customary fiber stress of 16,000 pounds per square inch used in building construction.

These tables also give the length of span at which the safe load, based on 16,000 pounds per square inch extreme fiber stress, will result in a deflection amounting to 1/360 of the length of the span in feet. The loads given in all cases include the weight of the beam itself, which weight should be deducted from the gross capacity of the beam to determine the net load, should the accuracy of the calculation require such refinement.

It has been assumed in all cases in these tables that the loads are applied perpendicular to the beam and in the plane of their webs.

Should the conditions under which the loads are applied to the beam involve the necessity of resisting forces outside of this assumption, it will not be safe to use these tabular loads, and the required section would then have to be obtained by the application of the general theory of flexure.

For angles and zees and other unsymmetrical sections, it will be necessary to see that the section is so secured as to prevent any twisting, as otherwise, on account of the shape of the section, failure would occur with a much lower load.

In building construction, where beams carry ceilings having a plastered finish, experience has indicated that vertical deflection of the beams should be limited to not more than 1/360 of the span in length, or as it is sometimes expressed, 1/30 of an inch for each foot of span.

This limit is indicated in the tables by the lower zigzag line and beams should not be used for a greater span than is thus indicated *unless the tabular* safe loads exceed the actual load to be carried on *the beam.*

# Explanation of Tables of Structural Sections Used as Beams

**Continued**

For the purpose of readily determining the deflection there will be found in these tables coefficients of deflection based on the loads given. These coefficients correspond to extreme fiber stresses of 16,000 pounds per square inch and are constant for all depths of beams. The deflection can readily be found for any span at the tabular load by dividing this coefficient by the depth of the beam in inches. To find the deflection under tabular load of sections unsymmetrical to the neutral axis such as angles and tees, divide the corresponding coefficient by twice the distance from neutral axis to extreme fiber. This distance can readily be obtained from the tables of properties of sections.

To find the deflection under any other fiber stress than of the 16,000 pounds per square inch used in the tables, it will be necessary to multiply the tabular coefficient of deflection for the span in question by the proposed fiber stress and divide the product by 16,000. This will give a new coefficient from which the desired deflection can be obtained.

The safe loads given in these tables are further based on the assumption that the compression flanges of the section will be secured against lateral deflection. The better class of construction specifications usually provide that no beam shall be used in which the compression flange is without lateral support for a distance exceeding forty times its width, and that the unit stress should be reduced whenever the unsupported width exceeds ten times the flange width. Placed in tabular form this reduction should be as follows:

10 times flange width Full tabular load
15 times flange width 90% tabular load
20 times flange width 81% tabular load
25 times flange width 71% tabular load
30 times flange width 62% tabular load
35 times flange width 53% tabular load
40 times flange width 43% tabular load

*The expert designer* will readily recognize the danger arising from *the use of a long narrow* beam without lateral support, and while

## Explanation of Tables of Structural Sections Used as Beams

**Continued**

there may be conditions under which the use of such a beam would be justified, for all ordinary cases the specification limit of forty times the flange width for the unsupported length should be adhered to. Particularly as, in addition to the tendency to lateral deflection due to vertical loading, there is always the possibility of developing other lateral influences through the action of floor arches, wind stresses or other incidental loadings that are frequently neglected or lost sight of in designing.

It is further assumed that all loads are static. Where moving loads are to be cared for, it will be necessary to reduce the stress in the material, either by reducing the allowable unit stresses used in designing or else by increasing the theoretical loads. Where loads are suddenly applied, the resulting stresses are greater than would be due to the same load carried as a static load. These stresses increase as the time of application of the load is decreased. When the load is applied instantaneously, the stresses due to that load are double the stress due to a quiescent load of the same amount.

Where the loading is such as to produce impact or percussion, the stresses resulting therefrom are dynamic and are to be measured by the laws governing the energy of bodies in motion. There are certain empirical formulae that may be used in determining the approximate fiber stress, also the deflection due to a load applied with impact at the center of a beam supported at both ends. These are as follows:

$$fd = f\left(1 + \sqrt{\frac{2mh}{D} + 1}\right) \text{ and } Dd = D + \sqrt{2mhD + D^2}$$

in which formulae the following symbols are used:

$W$ = Weight of load, in pounds.

$W_1$ = Weight of beam, in pounds.

$h$ = Height of fall, in inches.

$f$ = Extreme fiber stress due to static load, $W+W_1$, in pounds per square inch.

$fd$ = Extreme fiber stress due to dynamic load, W, in pounds per square inch.

# Explanation of Tables of Structural Sections Used as Beams

**Continued**

$D$ = Deflection due to static load, $W + W_1$, in inches.

$Dd$ = Deflection due to dynamic load, $W$, in inches.

$$m = \frac{35\,W}{35\,W + 17\,W_1}$$

On account of the excess metal required in the webs of beams and channels to satisfy rolling conditions, the safe loads for beams and channels are computed almost solely with reference to the stresses due to flexure, and, under uniformly distributed loads, the spans given will not produce a shearing stress in the webs greater than 10,000 pounds per square inch, which is within that allowed by the majority of good construction specifications. Conditions can arise, however, for instance with beams subjected to heavy loads that are concentrated near the supports, or when beams with short spans are loaded with a uniformly distributed load, that would absorb their full carrying capacity as regards flexure. It can be readily seen that under these conditions bending moments developed may be small as compared with the reactions at the supports, so that while the beam may be amply strong to resist bending it may be in a precarious condition as regards shearing stresses, or may buckle the webs as a result of vertical stresses in the webs.

For such conditions the safe carrying capacity of the beam is limited by the capacity to resist shearing or buckling of the web rather than by the ability of the flanges to resist bending.

In the consideration of the loading of beams, there remains one other point to be considered, and that is the possibility of the buckling or crippling of the webs, either at points of concentrated loading or under the influence of the reactions from the supports.

The resistance of a beam to such crippling is largely a question of web thickness and the safe end reaction may be expressed by the formula $R = fb \times t\,(a + \frac{d}{4})$ and the crippling under an inter-

# Explanation of Tables of Structural Sections Used as Beams

**Continued**

mediate concentrated load may be expressed by the formula $W = 2fb \times t \quad (a' + \frac{d}{4})$. In which formulae $R$ represents the end reaction, $W$ the intermediate concentrated load, $t$ the thickness of web, $d$ the depth of the beam, $a'$ half the distance over which the concentrated load is distributed, $a$ the distance which the end of the beam rests upon the supports, and $fb$ the safe carrying capacity of the web against buckling, for which the usual column formulae of $16{,}000 - 70\,\frac{l}{r}$ can be used, modifying it, however, so that in place of $l$ there is used one-half the depth of the beam.

Continued on next page.

# Explanation of Tables of Structural Sections Used as Beams

**Continued**

Placed in tabular form the capacity of beams to resist shear buckling and end reaction is as follows:

| Depth of Beam, Inches | Weight per Foot, Pounds | Thickness of Web, Inches | Total Allowable Web Shear at 10,000 Pounds per Square Inch, Pounds | Allowable Buckling Stress (*fb*), Pounds per Square Inch | Maximum End Reaction, Assuming 3½" Bearing, Pounds |
|---|---|---|---|---|---|
| 24 | 115.0 | .750 | 180,000 | 12,120 | 86,360 |
| 24 | 80.0 | .500 | 120,000 | 10,180 | 48,360 |
| 20 | 100.0 | .884 | 176,800 | 13,260 | 99,640 |
| 20 | 65.0 | .500 | 100,000 | 11,150 | 47,390 |
| 18 | 90.0 | .807 | 145,260 | 13,300 | 85,870 |
| 18 | 55.0 | .460 | 82,800 | 11,260 | 41,420 |
| 15 | 75.0 | .882 | 132,300 | 13,940 | 89,140 |
| 15 | 42.0 | .410 | 61,500 | 11,570 | 34,390 |
| 12 | 55.0 | .821 | 98,520 | 14,230 | 75,940 |
| 12 | 31.5 | .350 | 42,000 | 11,840 | 26,940 |
| 10 | 40.0 | .749 | 74,900 | 14,380 | 64,620 |
| 10 | 25.0 | .310 | 31,000 | 12,090 | 22,490 |
| 9 | 35.0 | .732 | 65,880 | 14,510 | 61,070 |
| 9 | 21.0 | .275 | 24,750 | 12,080 | 19,100 |
| 8 | 25.5 | .541 | 43,280 | 14,210 | 42,280 |
| 8 | 18.0 | .270 | 21,600 | 12,410 | 18,430 |
| 7 | 20.0 | .458 | 32,060 | 14,150 | 34,020 |
| 7 | 15.0 | .250 | 17,500 | 12,600 | 16,540 |
| 6 | 17.25 | .475 | 28,500 | 14,470 | 34,370 |
| 6 | 12.25 | .230 | 13,800 | 12,840 | 14,770 |
| 5 | 14.75 | .504 | 25,200 | 14,800 | 35,430 |
| 5 | 9.75 | .210 | 10,500 | 13,110 | 13,080 |
| 4 | 10.5 | .410 | 16,400 | 14,820 | 27,340 |
| 4 | 7.5 | .190 | 7,600 | 13,460 | 11,510 |
| *3* | *7.5* | .361 | 10,830 | 15,000 | 23,020 |
| *3* | *5.5* | .170 | 5,100 | 13,860 | 10,010 |

# Bending Moments and Deflection of Beams

## Various Systems of Loading

## Notation in Formulae

$A$ = Area of section, in square inches.

$n$ = Distance from center line of gravity to extreme fiber, in inches.

$I$ = Moment of inertia about center line of gravity, in inches.

$Ms$ = Static moment, in inches.

$S$ = Section modulus = $I/n$, in inches.

$r$ = Radius of gyration = $\sqrt{I/A}$, in inches.

$f$ = Bending stress in extreme fiber, in pounds per square inch.

$fb$ = Resistance of web, in pounds per square inch.

$E$ = Modulus of elasticity, in pounds per square inch, about 29,000,000.

$L$ = Length of section, in feet.

$l$ = Length of section, in inches.

$d$ = Depth of section, in inches.

$b$ = Width of section, in inches.

$t$ = Thickness of section, in inches.

$W$, $W1$, $W2$ = Superimposed loads supported by beam, in pounds.

$w$ = Superimposed load, in pounds per unit length of area.

$W\ max$ = Maximum safe load at point given, in pounds.

$R$, $R1$ = Reactions at points of support, in pounds.

$V$ = Vertical shear, in pounds.

$M$, $M1$, M2 = Bending moments at points given, in inch pounds.

$M\ max$ = Maximum bending moment, in inch pounds.

$Mr$ = Maximum resisting moment, in inch pounds = $f\ I/n = f\ S$.

$D$, $D1$ = Deflections at points given, in inches.

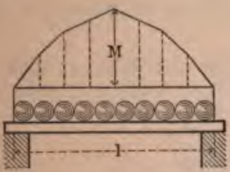
$D\ max$ = Maximum deflection at point given, in inches.

# Bending Moments and Deflections of Beams

## Various Systems of Loading

Continued

1. Beam supported at both ends and uniformly loaded.



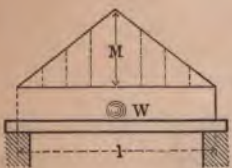

Max. shear $= \frac{W}{2}$

$M$ max. at center $= \frac{Wl}{8}$

$W$ max. $= \frac{8fs}{l}$

$D$ max. $= \frac{Wl^3}{78.6EI}$

2. Beam supported at both ends with load concentrated at the middle.



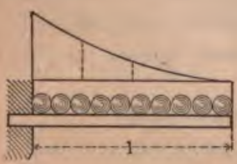

Max. shear $= \frac{W}{2}$

$M$ max., at point of load $= \frac{Wl}{4}$

$W$ max. $= \frac{4fs}{l}$

$D$ max. $= \frac{Wl^3}{48EI}$

3. Beam fixed at one end, unsupported at the other and uniformly loaded.




Max. shear $= W$

$M$ max., at point of support $= \frac{Wl}{2}$

$W$ max. $= \frac{2fs}{l}$

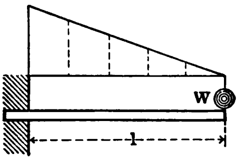
$D$ max. $= \frac{Wl^3}{8EI}$

# Bending Moments and Deflections of Beams

## Various Systems of Loading

### Continued

4. Beam fixed at one end, unsupported at the other, with load concentrated at the free end.



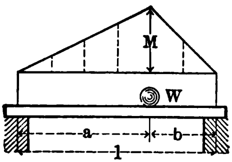

Max. shear $= W$

$M$ max., at point of support $= W\,l$

$W$ max. $= \dfrac{f\,s}{l}$

$D$ max. $= \dfrac{W\,l^3}{3\,E\,I}$

5. Beam supported at both ends with load concentrated at any point.




Max. shear if $b$ is greater than $a$ $= \dfrac{W\,b}{l}$

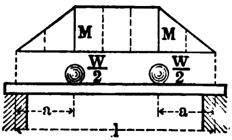
Max. shear if $a$ is greater than $b$ $= \dfrac{W\,a}{l}$

$M$ max., at point of load $= \dfrac{W\,a\,b}{l}$

$W$ max. $= \dfrac{f\,s\,l}{a\,b}$

$D$ max. $= \dfrac{W\,a\,b\,(a + 2\,b)\,\sqrt{3\,a\,(a + 2\,b)}}{27\,E\,I\,l}$

6. Beam supported at both ends with two symmetrical loads.




Max. shear $= \dfrac{W}{2}$

$M$ max. at and between loads $= \dfrac{W\,a}{2}$

$W$ max. $= \dfrac{2\,f\,s}{a}$

$D$ max. $= \dfrac{W\,a}{48\,E\,I}(3\,l^2 - 4\,a^2)$

# Bending Moments and Deflections of Beams

## Various Systems of Loading

### Continued

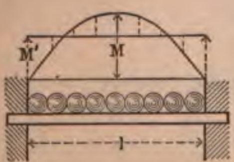
7. Beam supported at both ends with loads concentrated at various points.


$$R = \frac{W\,b + W_1\,b_1 + W_2\,b_2}{l}$$

$$R_1 = \frac{W\,a + W_1\,a_1 + W_2\,a_2}{l}$$

$M$ at $W = R\,a$
Max. if $W$ = or is greater than $R$
$M$ at $W_1 = R\,a_1 - W\,(a_1 - a)$
$M$ max. if $W_1 + W = R$ or is greater than $R$
$M$ max. if $W_1 + W_2 = R_1$ or is greater than $R_1$
$M$ at $W_2 = R\,a_2 - W\,(a_2 - a) - W_1\,(a_2 - a_1)$
$M$ max. if $W_2 = R_1$ or is greater than $R_1$

8. Beam fixed at both ends and uniformly loaded.




Distance of points of extra flexure from supports $= .2113 \times l$

Max. bending mom. at points of support $= \dfrac{W\,l}{12}$

Bending mom. at middle of beam $= \dfrac{W\,l}{24}$

Max. shear at points of support $= \dfrac{W}{2}$

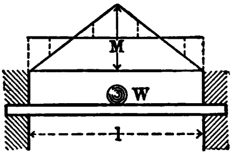
$D$ max. $= \dfrac{W\,l^3}{384\,E\,I}$

# Bending Moments and Deflections of Beams

## Various Systems of Loading

Continued

9. Beam fixed at both ends with load concentrated at the middle.




Distance of points of contra-flexure from supports $= \frac{1}{4} l$

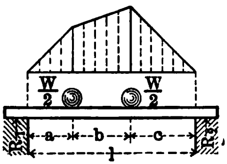
Max. bending mom. at points of support $= \frac{P\,l}{8}$

Bending mom. at middle of beam $= \frac{P\,l}{8}$

Max. shear at points of support $= \frac{P}{2}$

Max. deflection $= \frac{P\,l^3}{192\,E\,I}$

10. Beam supported at both ends with two unsymmetrical loads concentrated at various points.




$R_1$ max. shear if $a$ is less than $c$ $= \frac{W}{2\,l}(l - a + c)$

$R_2$ $= \frac{W}{2\,l}(l + a - c)$

$M$ max. distance $c$ (when $c$ is less than $a$) $= R_1\,C = \frac{W\,c}{2\,l}(l + a - c)$

$W$ max. (when $c$ is less than $a$) $= \frac{2\,l\,f\,s}{c\,(l + a - c)}$

# Bending Moments and Deflections of Beams

## Various Systems of Loading

### Continued

11. Beam supported at both ends with a uniform load partially distributed.


$R_1$ max. shear if $a$ is less than $c$ $= \dfrac{W\,(2\,c + b)}{2\,l}$

$R_2$ $= \dfrac{W\,(2\,a + b)}{2\,l}$

$M$ max. dist. $a + \dfrac{R_1\,b}{W}$ $= \dfrac{W\,(2\,c + b)\,[4\,a\,l + b\,(2\,c + b)]}{8\,l^2}$

$W$ max. $= \dfrac{8\,l^2\,f\,s}{(2\,c + b)\,[4\,a\,l + b\,(2\,c + b)]}$

12. Beam supported at both ends with a uniform load partially discontinued.


$R_1$ max. shear if $W_1$ is greater than $W_2$ $= \dfrac{W_1\,(2\,l - a) + W_1\,c}{2\,l}$

$R_2$ $= \dfrac{W_2\,(2\,l - c) + W\,a}{2\,l}$

$M$ max. dist. $\times \dfrac{2\,W_1\,a\,l - W_1\,a^2 + W_2\,c\,a}{2\,W_1\,l}$ $= \dfrac{R^2\,a}{2\,W}$

$W$ max. when $W_1\,a$ is greater than $W_2\,c$ $= \dfrac{R^2\,a}{2\,f\,s}$

# Structural Beams

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Beam**

| Span in Feet | Depth and Weight of Sections | | | | | | | | Co-efficient of Deflec-tion |
|---|---|---|---|---|---|---|---|---|---|
| | 24-Inch | | | | | | | | |
| | 115 lbs. | 110 lbs. | 105 lbs. | 100 lbs. | 95 lbs. | 90 lbs. | 85 lbs. | 80 lbs. | |
| | | | | 361.9 | | | | | |
| 6 | | | | 352.5 | 332.6 | 302.9 | | | 0.60 |
| 7 | 360.0 | 330.2 | | 302.2 | 293.2 | 284.2 | 273.6 | 240.0 | 0.81 |
| 8 | 328.4 | 320.4 | 300.0 | 264.4 | 256.6 | 248.7 | 240.9 | 231.9 | 1.06 |
| 9 | 291.9 | 284.8 | 277.7 | 235.0 | 228.0 | 221.1 | 214.1 | 206.1 | 1.34 |
| 10 | 262.7 | 256.3 | 249.9 | 211.5 | 205.2 | 199.0 | 192.7 | 185.5 | 1.66 |
| 11 | 238.8 | 233.0 | 227.2 | 192.3 | 186.6 | 180.9 | 175.2 | 168.7 | 2.00 |
| 12 | 218.9 | 213.6 | 208.3 | 176.3 | 171.0 | 165.8 | 160.6 | 154.6 | 2.38 |
| 13 | 202.1 | 197.2 | 192.2 | 162.7 | 157.9 | 153.1 | 148.2 | 142.7 | 2.80 |
| 14 | 187.7 | 183.1 | 178.5 | 151.1 | 146.6 | 142.1 | 137.6 | 132.5 | 3.24 |
| 15 | 175.1 | 170.9 | 166.6 | 141.0 | 136.8 | 132.6 | 128.5 | 123.7 | 3.72 |
| 16 | 164.2 | 160.2 | 156.2 | 132.2 | 128.3 | 124.4 | 120.4 | 116.0 | 4.24 |
| 17 | 154.5 | 150.8 | 147.0 | 124.4 | 120.7 | 117.0 | 113.4 | 109.1 | 4.78 |
| 18 | 146.0 | 142.4 | 138.8 | 117.5 | 114.0 | 110.5 | 107.1 | 103.1 | 5.36 |
| 19 | 138.3 | 134.9 | 131.5 | 111.3 | 108.0 | 104.7 | 101.4 | 97.6 | 5.98 |
| 20 | 131.4 | 128.2 | 125.0 | 105.8 | 102.6 | 99.5 | 96.3 | 92.8 | 6.62 |
| 21 | 125.1 | 122.1 | 119.0 | 100.7 | 97.7 | 94.7 | 91.8 | 88.3 | 7.30 |
| 22 | 119.4 | 116.5 | 113.6 | 96.1 | 93.3 | 90.4 | 87.6 | 84.3 | 8.01 |
| 23 | 114.2 | 111.4 | 108.7 | 92.0 | 89.2 | 86.5 | 83.8 | 80.7 | 8.76 |
| 24 | 109.5 | 106.8 | 104.1 | 88.1 | 85.5 | 82.9 | 80.3 | 77.3 | 9.53 |
| 25 | 105.1 | 102.5 | 100.0 | 84.6 | 82.1 | 79.6 | 77.1 | 74.2 | 10.35 |
| 26 | 101.0 | 98.6 | 96.1 | 81.4 | 78.9 | 76.5 | 74.1 | 71.4 | 11.19 |
| 27 | 97.3 | 94.9 | 92.6 | 78.3 | 76.0 | 73.7 | 71.4 | 68.7 | 12.07 |
| 28 | 93.8 | 91.5 | 89.3 | 75.5 | 73.3 | 71.1 | 68.8 | 66.3 | 12.98 |
| 29 | 90.6 | 88.4 | 86.2 | 72.9 | 70.8 | 68.6 | 66.4 | 64.0 | 13.92 |
| 30 | 87.6 | 85.4 | 83.3 | 70.5 | 68.4 | 66.3 | 64.2 | 61.8 | 14.90 |
| 31 | 84.7 | 82.7 | 80.6 | 68.2 | 66.2 | 64.2 | 62.2 | 59.8 | 15.91 |
| 32 | 82.1 | 80.1 | 78.1 | 66.1 | 64.1 | 62.2 | 60.2 | 58.0 | 16.95 |
| 33 | 79.6 | 77.7 | 75.7 | 64.1 | 62.2 | 60.3 | 58.4 | 56.2 | 18.03 |
| 34 | 77.3 | 75.4 | 73.5 | 62.2 | 60.4 | 58.5 | 56.7 | 54.6 | 19.13 |
| 35 | 75.1 | 73.2 | 71.4 | 60.4 | 58.6 | 56.8 | 55.1 | 53.0 | 20.28 |
| 36 | 73.0 | 71.2 | 69.4 | 58.8 | 57.0 | 55.3 | 53.5 | 51.5 | 21.45 |
| 37 | 71.0 | 69.3 | 67.5 | 57.2 | 55.5 | 53.8 | 52.1 | 50.1 | 22.66 |
| 38 | 69.1 | 67.5 | 65.8 | 55.7 | 54.0 | 52.4 | 50.7 | 48.8 | 23.90 |
| 39 | 67.4 | 65.7 | 64.1 | 54.2 | 52.6 | 51.0 | 49.4 | 47.6 | 25.18 |
| 40 | 65.7 | 64.1 | 62.5 | 52.9 | 51.3 | 49.7 | 48.2 | 46.4 | 26.48 |
| 41 | 64.1 | 62.5 | 61.0 | 51.6 | 50.1 | 48.5 | 47.0 | 45.3 | 27.82 |
| 42 | 62.6 | 61.0 | 59.5 | 50.4 | 48.9 | 47.4 | 45.9 | 44.2 | 29.20 |
| 43 | 61.1 | 59.6 | 58.1 | 49.2 | 47.7 | 46.3 | 44.8 | 43.1 | 30.60 |
| 44 | 59.7 | 58.3 | 56.8 | 48.1 | 46.6 | 45.2 | 43.8 | 42.2 | 32.04 |
| 45 | 58.4 | 57.0 | 55.5 | 47.0 | 45.6 | 44.2 | 42.8 | 41.2 | 33.52 |
| 46 | 57.1 | 55.7 | 54.3 | 46.0 | 44.6 | 43.3 | 41.9 | 40.3 | 35.02 |
| 47 | 55.9 | 54.1 | 53.2 | 45.0 | 43.7 | 42.3 | 41.0 | 39.5 | 36.56 |
| 48 | 54.7 | 53.4 | 52.1 | 44.1 | 42.8 | 41.5 | 40.1 | 38.7 | 38.14 |
| 49 | 53.6 | 52.3 | 51.0 | 43.2 | 41.9 | 40.6 | 39.3 | 37.9 | 39.74 |
| 50 | 52.5 | 51.3 | 50.0 | 42.3 | 41.0 | 39.8 | 38.5 | 37.1 | 41.38 |

Loads above horizontal lines will produce maximum allowable shear in webs.
*Loads below dotted* lines will produce excessive deflections.
*For maximum safe loads, see page 140.*

# Structural Beams

## Allowable Uniform Loads in Thousands of Pounds

**Continued**

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**

**Safe Loads Include Weight of Beam**

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20-Inch | | | | | | | | 18-Inch | | | | |
| | 100 lbs. | 95 lbs. | 90 lbs. | 85 lbs. | 80 lbs. | 75 lbs. | 70 lbs. | 65 lbs. | 90 lbs. | 85 lbs. | 80 lbs. | 75 lbs. | |
| | 353.6 | | | | | | | | | | | | |
| 5 | 353.2 | | | | | | | | | | | | 0.41 |
| | | 324.0 | 294.8 | | | 259.6 | 230.0 | | 290.5 | 261.0 | | | |
| 6 | 294.3 | 285.6 | 276.9 | 265.2 | 240.0 | 225.6 | 216.8 | 200.0 | 249.0 | 241.1 | 231.8 | 202.3 | 0.60 |
| 7 | 252.3 | 244.8 | 237.7 | 229.9 | 223.4 | 193.3 | 185.9 | 178.2 | 213.4 | 206.7 | 200.0 | 193.2 | 0.81 |
| 8 | 220.7 | 214.2 | 207.7 | 201.1 | 195.5 | 169.2 | 162.6 | 155.9 | 186.7 | 180.8 | 175.0 | 169.1 | 1.06 |
| 9 | 196.2 | 190.4 | 184.6 | 178.8 | 173.8 | 150.4 | 144.6 | 138.6 | 166.0 | 160.7 | 155.5 | 150.3 | 1.34 |
| 10 | 176.6 | 171.4 | 166.1 | 160.9 | 156.4 | 135.3 | 130.1 | 124.7 | 149.4 | 144.7 | 140.0 | 135.3 | 1.66 |
| 11 | 160.5 | 155.8 | 151.0 | 146.3 | 142.2 | 123.0 | 118.3 | 113.4 | 135.8 | 131.5 | 127.2 | 123.0 | 2.00 |
| 12 | 147.2 | 142.8 | 138.5 | 134.1 | 130.3 | 112.8 | 108.4 | 104.0 | 124.5 | 120.6 | 116.6 | 112.7 | 2.38 |
| 13 | 135.8 | 131.8 | 127.8 | 123.8 | 120.3 | 104.1 | 100.1 | 96.0 | 114.9 | 111.3 | 107.7 | 104.1 | 2.80 |
| 14 | 126.1 | 122.4 | 118.7 | 114.9 | 111.7 | 96.7 | 92.9 | 89.1 | 106.7 | 103.3 | 100.0 | 96.6 | 3.24 |
| 15 | 117.7 | 114.2 | 110.8 | 107.3 | 104.3 | 90.2 | 86.7 | 83.2 | 99.6 | 96.4 | 93.3 | 90.2 | 3.72 |
| 16 | 110.4 | 107.1 | 103.8 | 100.6 | 97.7 | 84.6 | 81.3 | 78.0 | 93.4 | 90.4 | 87.5 | 84.5 | 4.24 |
| 17 | 103.9 | 100.8 | 97.7 | 94.1 | 92.0 | 79.6 | 76.5 | 73.4 | 87.9 | 85.1 | 82.3 | 79.6 | 4.78 |
| 18 | 98.1 | 95.2 | 92.3 | 89.4 | 86.9 | 76.3 | 72.3 | 69.3 | 83.0 | 80.4 | 77.8 | 75.1 | 5.36 |
| 19 | 92.9 | 90.2 | 87.4 | 84.7 | 82.3 | 71.2 | 68.5 | 65.7 | 78.6 | 76.1 | 73.7 | 71.2 | 5.98 |
| 20 | 88.3 | 85.7 | 83.1 | 80.5 | 78.2 | 67.7 | 65.1 | 62.4 | 74.7 | 72.3 | 70.0 | 67.6 | 6.62 |
| 21 | 84.1 | 81.6 | 79.1 | 76.6 | 74.5 | 64.4 | 62.0 | 59.4 | 71.1 | 68.9 | 66.7 | 64.4 | 7.30 |
| 22 | 80.3 | 77.9 | 75.5 | 73.1 | 71.1 | 61.5 | 59.1 | 56.7 | 67.9 | 65.8 | 63.6 | 61.5 | 8.01 |
| 23 | 76.8 | 74.5 | 72.2 | 70.0 | 68.0 | 58.8 | 56.6 | 54.2 | 64.9 | 62.9 | 60.9 | 58.8 | 8.76 |
| 24 | 73.6 | 71.4 | 69.2 | 67.0 | 65.2 | 56.4 | 54.2 | 52.0 | 62.2 | 60.3 | 58.3 | 56.4 | 9.53 |
| 25 | 70.6 | 68.5 | 66.5 | 64.4 | 62.6 | 54.1 | 52.0 | 49.9 | 59.8 | 57.9 | 56.0 | 54.1 | 10.35 |
| 26 | 67.9 | 65.9 | 63.9 | 61.9 | 60.2 | 52.1 | 50.0 | 48.0 | 57.5 | 55.6 | 53.8 | 52.0 | 11.19 |
| 27 | 65.4 | 63.5 | 61.5 | 59.6 | 57.9 | 50.1 | 48.2 | 46.2 | 55.3 | 53.6 | 51.8 | 50.1 | 12.07 |
| 28 | 63.1 | 61.2 | 59.3 | 57.5 | 55.9 | 48.3 | 46.5 | 44.6 | 53.3 | 51.7 | 50.0 | 48.3 | 12.98 |
| 29 | 60.9 | 59.1 | 57.3 | 55.5 | 53.9 | 46.7 | 44.9 | 43.0 | 51.5 | 49.9 | 48.3 | 46.6 | 13.92 |
| 30 | 58.9 | 57.1 | 55.4 | 53.6 | 52.1 | 45.1 | 43.4 | 41.6 | 49.8 | 48.2 | 46.7 | 45.1 | 14.90 |
| 31 | 57.0 | 55.3 | 53.6 | 51.9 | 50.5 | 43.7 | 42.0 | 40.2 | 48.2 | 46.7 | 45.2 | 43.6 | 15.91 |
| 32 | 55.2 | 53.6 | 51.9 | 50.3 | 48.9 | 42.3 | 40.7 | 39.0 | 46.7 | 45.2 | 43.7 | 42.3 | 16.95 |
| 33 | 53.5 | 51.9 | 50.4 | 48.8 | 47.4 | 41.0 | 39.4 | 37.8 | 45.3 | 43.8 | 42.4 | 41.0 | 18.03 |
| 34 | 51.9 | 50.4 | 48.9 | 47.3 | 46.0 | 39.8 | 38.3 | 36.7 | 43.9 | 42.6 | 41.2 | 39.8 | 19.13 |
| 35 | 50.5 | 49.0 | 47.5 | 46.0 | 44.7 | 38.7 | 37.2 | 35.6 | 42.7 | 41.3 | 40.0 | 38.6 | 20.28 |
| 36 | 49.1 | 47.6 | 46.2 | 44.7 | 43.4 | 37.6 | 36.1 | 34.7 | 41.5 | 40.2 | 38.9 | 37.6 | 21.45 |
| 37 | 47.7 | 46.3 | 44.9 | 43.5 | 42.3 | 36.6 | 35.2 | 33.7 | 40.4 | 39.1 | 37.8 | 36.6 | 22.66 |
| 38 | 46.5 | 45.1 | 43.7 | 42.3 | 41.2 | 35.6 | 34.2 | 32.8 | 39.3 | 38.1 | 36.8 | 35.6 | 23.90 |
| 39 | 45.3 | 43.9 | 42.6 | 41.3 | 40.1 | 34.7 | 33.4 | 32.0 | | | | | 25.18 |
| 40 | 44.1 | 42.8 | 41.5 | 40.2 | 39.1 | 33.8 | 32.5 | 31.2 | | | | | 26.48 |
| *41* | 43.1 | 41.8 | 40.5 | 39.2 | 38.1 | 33.0 | 31.7 | 30.4 | | | | | 27.82 |
| *42* | *42.0* | *40.8* | *39.6* | 38.3 | 37.2 | 32.2 | 31.0 | 29.7 | | | | | 29.20 |

*Loads above horizontal lines will produce maximum allowable shear in webs.*
*Loads below dotted lines will produce excessive deflections.*
*For maximum safe loads, see page 140.*

# Structural Beams

## Allowable Uniform Loads in Thousands of Pounds

### Continued

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Beam**

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | | Co-efficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18 Inch | | | | 15 Inch | | | | | | | | |
| | 70 lbs. | 65 lbs. | 60 lbs. | 55 lbs. | 75 lbs. | 70 lbs. | 65 lbs. | 60 lbs. | 55 lbs. | 50 lbs. | 45 lbs. | 42 lbs. | |
| | | | | | 264.6 | | | | 196.8 | | | | |
| 4 | 258.8 | 229.3 | 199.8 | | 245.8 | 235.2 | 205.8 | 177.0 | 181.7 | 167.4 | 138.0 | | 0.27 |
| 5 | 218.4 | 208.9 | 199.5 | | 196.6 | 188.8 | 180.9 | 173.2 | 145.4 | 137.5 | 129.7 | | 0.41 |
| | | | | 165.6 | | | | | | | | 123.0 | |
| 6 | 182.0 | 174.1 | 166.3 | 157.1 | 163.8 | 157.3 | 150.8 | 144.4 | 121.1 | 114.6 | 108.1 | 104.8 | 0.60 |
| 7 | 156.0 | 149.2 | 142.5 | 134.7 | 140.4 | 134.8 | 129.2 | 123.7 | 103.8 | 98.2 | 92.6 | 89.8 | 0.81 |
| 8 | 136.5 | 130.6 | 124.7 | 117.9 | 122.9 | 118.0 | 113.1 | 108.3 | 90.8 | 85.9 | 81.0 | 78.5 | 1.06 |
| 9 | 121.3 | 116.1 | 110.9 | 104.8 | 109.2 | 104.9 | 100.5 | 96.2 | 80.8 | 76.4 | 72.0 | 69.8 | 1.34 |
| 10 | 109.2 | 104.5 | 99.8 | 94.3 | 98.3 | 94.4 | 90.5 | 86.6 | 72.7 | 68.8 | 64.8 | 62.8 | 1.66 |
| 11 | 99.3 | 95.0 | 90.7 | 85.7 | 89.4 | 85.8 | 82.2 | 78.7 | 66.1 | 62.5 | 58.9 | 57.1 | 2.00 |
| 12 | 91.0 | 87.1 | 83.1 | 78.6 | 81.9 | 78.7 | 75.4 | 72.2 | 60.6 | 57.3 | 54.0 | 52.4 | 2.38 |
| 13 | 84.0 | 80.4 | 76.7 | 72.5 | 75.6 | 72.6 | 69.6 | 66.6 | 55.9 | 52.9 | 49.9 | 48.3 | 2.80 |
| 14 | 78.0 | 74.6 | 71.3 | 67.3 | 70.2 | 67.4 | 64.6 | 61.9 | 51.9 | 49.1 | 46.3 | 44.9 | 3.24 |
| 15 | 72.8 | 69.6 | 66.5 | 62.9 | 65.5 | 62.9 | 60.3 | 57.7 | 48.5 | 45.8 | 43.2 | 41.9 | 3.72 |
| 16 | 68.2 | 65.3 | 62.4 | 58.9 | 61.4 | 59.0 | 56.5 | 54.1 | 45.4 | 43.0 | 40.5 | 39.3 | 4.24 |
| 17 | 64.2 | 61.5 | 58.7 | 55.5 | 57.8 | 55.5 | 53.2 | 50.9 | 42.8 | 40.4 | 38.1 | 37.0 | 4.78 |
| 18 | 60.7 | 58.0 | 55.4 | 52.4 | 54.6 | 52.4 | 50.3 | 48.1 | 40.4 | 38.2 | 36.0 | 34.9 | 5.36 |
| 19 | 57.5 | 55.0 | 52.5 | 49.6 | 51.7 | 49.7 | 47.6 | 45.6 | 38.3 | 36.2 | 34.1 | 33.1 | 5.98 |
| 20 | 54.6 | 52.2 | 49.9 | 47.1 | 49.2 | 47.2 | 45.2 | 43.3 | 36.3 | 34.4 | 32.4 | 31.4 | 6.62 |
| 21 | 52.0 | 49.7 | 47.5 | 44.9 | 46.8 | 44.9 | 43.1 | 41.2 | 34.6 | 32.7 | 30.9 | 29.9 | 7.30 |
| 22 | 49.6 | 47.5 | 45.3 | 42.9 | 44.7 | 42.9 | 41.1 | 39.4 | 33.0 | 31.3 | 29.5 | 28.6 | 8.01 |
| 23 | 47.5 | 45.4 | 43.4 | 41.0 | 42.7 | 41.0 | 39.3 | 37.7 | 31.6 | 29.9 | 28.2 | 27.3 | 8.76 |
| 24 | 45.5 | 43.5 | 41.6 | 39.3 | 41.0 | 39.3 | 37.7 | 36.1 | 30.3 | 28.6 | 27.0 | 26.2 | 9.53 |
| 25 | 43.7 | 41.8 | 39.9 | 37.7 | 39.3 | 37.8 | 36.2 | 34.6 | 29.1 | 27.5 | 25.9 | 25.1 | 10.35 |
| 26 | 42.0 | 40.2 | 38.4 | 36.3 | 37.8 | 36.3 | 34.8 | 33.3 | 28.0 | 26.4 | 24.9 | 24.2 | 11.19 |
| 27 | 40.4 | 38.7 | 37.0 | 34.9 | 36.4 | 35.0 | 33.5 | 32.1 | 26.9 | 25.5 | 24.0 | 23.3 | 12.07 |
| 28 | 39.0 | 37.3 | 35.6 | 33.7 | 35.1 | 33.7 | 32.3 | 30.9 | 26.0 | 24.6 | 23.2 | 22.4 | 12.98 |
| 29 | 37.6 | 36.0 | 34.4 | 32.5 | 33.9 | 32.5 | 31.2 | 29.9 | 25.1 | 23.7 | 22.4 | 21.7 | 13.92 |
| 30 | 36.4 | 34.8 | 33.3 | 31.4 | 32.8 | 31.5 | 30.2 | 28.9 | 24.2 | 22.9 | 21.6 | 20.9 | 14.90 |
| 31 | 35.2 | 33.7 | 32.2 | 30.4 | 31.7 | 30.4 | 29.2 | 27.9 | 23.4 | 22.2 | 20.9 | 20.3 | 15.91 |
| 32 | 34.1 | 32.6 | 31.2 | 29.5 | 30.7 | 29.5 | 28.3 | 27.1 | 22.7 | 21.5 | 20.3 | 19.6 | 16.95 |
| 33 | 33.1 | 31.7 | 30.2 | 28.6 | | | | | | | | | 18.03 |
| 34 | 32.1 | 30.7 | 29.3 | 27.7 | | | | | | | | | 19.13 |
| 35 | 31.2 | 29.8 | 28.5 | 26.9 | | | | | | | | | 20.28 |
| 36 | 30.3 | 29.0 | 27.7 | 26.2 | | | | | | | | | 21.45 |
| 37 | 29.5 | 28.2 | 27.0 | 25.5 | | | | | | | | | 22.66 |
| 38 | 28.7 | 27.5 | 26.3 | 24.8 | | | | | | | | | 23.90 |

Loads above horizontal lines will produce maximum allowable shear in webs.
*Loads below dotted lines will produce excessive deflections.*
*For maximum safe loads,* see page 140.

# Structural Beams

## Allowable Uniform Loads in Thousands of Pounds

**Continued**

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Beam**

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | Co-efficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 Inch | | | | | | 10 Inch | | | | |
| | 55 lbs. | 50 lbs. | 45 lbs. | 40 lbs. | 35 lbs. | 31½ lbs. | 40 lbs. | 35 lbs. | 30 lbs. | 25 lbs. | |
| | 197.0 | | | | | | 149.8 | 120.4 | | | |
| 3 | 190.2 | 167.8 | 138.2 | | 104.6 | | 112.8 | 104.1 | 91.0 | | 0.15 |
| 4 | 142.7 | 134.8 | 127.0 | 110.4 | 101.5 | 84.0 | 84.6 | 78.1 | 71.6 | 62.0 | 0.27 |
| 5 | 114.1 | 107.9 | 101.6 | 95.6 | 81.2 | 76.7 | 67.7 | 62.5 | 57.2 | 52.1 | 0.41 |
| 6 | 95.1 | 89.9 | 84.7 | 79.7 | 67.6 | 63.9 | 56.4 | 52.1 | 47.7 | 43.4 | 0.60 |
| 7 | 81.5 | 77.0 | 72.6 | 68.3 | 58.0 | 54.8 | 48.4 | 44.6 | 40.9 | 37.2 | 0.81 |
| 8 | 71.3 | 67.4 | 63.5 | 59.8 | 50.7 | 48.0 | 42.3 | 39.0 | 35.8 | 32.6 | 1.06 |
| 9 | 63.4 | 59.9 | 56.4 | 53.1 | 45.1 | 42.6 | 37.6 | 34.7 | 31.8 | 28.9 | 1.34 |
| 10 | 57.1 | 53.9 | 50.8 | 47.8 | 40.6 | 38.4 | 33.9 | 31.2 | 28.6 | 26.0 | 1.66 |
| 11 | 51.9 | 49.0 | 46.2 | 43.5 | 36.9 | 34.9 | 30.8 | 28.4 | 26.0 | 23.7 | 2.00 |
| 12 | 47.6 | 44.9 | 42.3 | 39.8 | 33.8 | 32.0 | 28.2 | 26.0 | 23.9 | 21.7 | 2.38 |
| 13 | 43.9 | 41.5 | 39.1 | 36.8 | 31.2 | 29.5 | 26.0 | 24.0 | 22.0 | 20.0 | 2.80 |
| 14 | 40.8 | 38.5 | 36.3 | 34.2 | 29.0 | 27.4 | 24.2 | 22.3 | 20.4 | 18.6 | 3.24 |
| 15 | 38.0 | 36.0 | 33.9 | 31.9 | 27.1 | 25.6 | 22.6 | 20.8 | 19.1 | 17.4 | 3.72 |
| 16 | 35.7 | 33.7 | 31.7 | 29.9 | 25.4 | 24.0 | 21.2 | 19.5 | 17.9 | 16.3 | 4.24 |
| 17 | 33.6 | 31.7 | 29.9 | 28.1 | 23.9 | 22.6 | 19.9 | 18.4 | 16.8 | 15.3 | 4.78 |
| 18 | 31.7 | 30.0 | 28.2 | 26.6 | 22.5 | 21.3 | 18.8 | 17.4 | 15.9 | 14.5 | 5.36 |
| 19 | 30.0 | 28.4 | 26.7 | 25.2 | 21.4 | 20.2 | 17.8 | 16.4 | 15.1 | 13.7 | 5.98 |
| 20 | 28.5 | 27.0 | 25.4 | 23.9 | 20.3 | 19.2 | 16.9 | 15.6 | 14.3 | 13.0 | 6.62 |
| 21 | 27.2 | 25.7 | 24.2 | 22.8 | 19.3 | 18.3 | 16.1 | 14.9 | 13.6 | 12.4 | 7.30 |
| 22 | 25.9 | 24.5 | 23.1 | 21.7 | 18.4 | 17.4 | 15.4 | 14.2 | 13.0 | 11.8 | 8.01 |
| 23 | 24.8 | 23.4 | 22.1 | 20.8 | 17.6 | 16.7 | | | | | 8.76 |
| 24 | 23.8 | 22.5 | 21.2 | 19.9 | 16.9 | 16.0 | | | | | 9.53 |
| 25 | 22.8 | 21.6 | 20.3 | 19.1 | 16.2 | 15.3 | | | | | 10.35 |
| 26 | 21.9 | 20.7 | 19.5 | 18.4 | 15.6 | 14.8 | | | | | 11.19 |
| 27 | | | | | | | | | | | 12.07 |
| 28 | | | | | | | | | | | 12.98 |
| 29 | | | | | | | | | | | 13.92 |
| 30 | | | | | | | | | | | 14.90 |
| 31 | | | | | | | | | | | 15.91 |
| 32 | | | | | | | | | | | 16.95 |

Loads above horizontal lines will produce maximum allowable shear in webs.
Loads below dotted lines will produce excessive deflections.
For maximum safe loads, see page 140.

# Structural Beams

## Allowable Uniform Loads in Thousands of Pounds

### Continued

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Beam**

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9 Inch | | | | 8 Inch | | | | 7 Inch | | | |
| | 35 lbs. | 30 lbs. | 25 lbs. | 21 lbs. | 25½ lbs. | 23 lbs. | 20½ lbs. | 18 lbs. | 20 lbs. | 17½ lbs. | 15 lbs. | |
| | 131.8 | 102.4 | 73.1 | | 86.6 | 71.8 | 57.1 | | 64.1 | 49.4 | | |
| 3 | 88.3 | 80.5 | 72.6 | | 60.8 | 57.3 | 53.9 | 43.2 | 42.9 | 39.8 | 35.0 | 0.15 |
| 4 | 66.2 | 60.4 | 54.5 | 49.5 | 45.6 | 43.0 | 40.4 | 37.9 | 32.1 | 29.9 | 27.6 | 0.27 |
| 5 | 53.0 | 48.3 | 43.6 | 39.9 | 36.5 | 34.4 | 32.3 | 30.3 | 25.7 | 23.9 | 22.1 | 0.41 |
| 6 | 44.2 | 40.2 | 36.3 | 33.2 | 30.4 | 28.7 | 26.9 | 25.3 | 21.4 | 19.9 | 18.4 | 0.60 |
| 7 | 37.9 | 34.5 | 31.1 | 28.5 | 26.1 | 24.6 | 23.1 | 21.7 | 18.4 | 17.1 | 15.8 | 0.81 |
| 8 | 33.1 | 30.2 | 27.2 | 24.9 | 22.8 | 21.5 | 20.2 | 19.0 | 16.1 | 14.9 | 13.8 | 1.06 |
| 9 | 29.4 | 26.8 | 24.2 | 22.2 | 20.3 | 19.1 | 18.0 | 16.9 | 14.3 | 13.3 | 12.3 | 1.34 |
| 10 | 26.5 | 24.1 | 21.8 | 19.9 | 18.2 | 17.2 | 16.2 | 15.2 | 12.9 | 11.9 | 11.0 | 1.66 |
| 11 | 24.1 | 22.0 | 19.8 | 18.1 | 16.6 | 15.6 | 14.7 | 13.8 | 11.7 | 10.9 | 10.0 | 2.00 |
| 12 | 22.1 | 20.1 | 18.2 | 16.6 | 15.2 | 14.3 | 13.5 | 12.6 | 10.7 | 10.0 | 9.2 | 2.38 |
| 13 | 20.4 | 18.6 | 16.8 | 15.3 | 14.0 | 13.2 | 12.4 | 11.7 | 9.9 | 9.2 | 8.5 | 2.80 |
| 14 | 18.9 | 17.2 | 15.6 | 14.2 | 13.0 | 12.3 | 11.5 | 10.8 | 9.2 | 8.5 | 7.9 | 3.24 |
| 15 | 17.7 | 16.1 | 14.5 | 13.3 | 12.2 | 11.5 | 10.8 | 10.1 | 8.6 | 8.0 | 7.4 | 3.72 |
| 16 | 16.6 | 15.1 | 13.6 | 12.5 | 11.4 | 10.8 | 10.1 | 9.5 | 8.0 | 7.5 | 6.9 | 4.24 |
| 17 | 15.6 | 14.2 | 12.8 | 11.7 | 10.7 | 10.1 | 9.5 | 8.9 | | | | 4.78 |
| 18 | 14.7 | 13.4 | 12.1 | 11.1 | 10.1 | 9.6 | 9.0 | 8.4 | | | | 5.36 |
| 19 | 13.9 | 12.7 | 11.5 | 10.5 | | | | | | | | 5.98 |
| 20 | 13.3 | 12.1 | 10.9 | 10.0 | | | | | | | | 6.62 |

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 Inch | | | 5 Inch | | | 4 Inch | | | | 3 Inch | | | |
| | 17¼ lbs. | 14¾ lbs. | 12¼ lbs. | 14¾ lbs. | 12¼ lbs. | 9¾ lbs. | 10½ lbs. | 9½ lbs. | 8½ lbs. | 7½ lbs. | 7½ lbs. | 6½ lbs. | 5½ lbs. | |
| | | | | | | | | | | | 21.7 | | | |
| 1 | 57.0 | | | 50.4 | 35.7 | | 32.8 | 27.0 | 21.0 | | 20.7 | 15.8 | 10.2 | 0.02 |
| 2 | 46.6 | 42.2 | 27.6 | 32.3 | 29.1 | 21.0 | 19.0 | 18.0 | 16.9 | 15.2 | 10.4 | 9.6 | 8.8 | 0.07 |
| 3 | 31.0 | 28.4 | 25.8 | 21.5 | 19.4 | 17.2 | 12.7 | 12.0 | 11.3 | 10.6 | 6.9 | 6.4 | 5.9 | 0.15 |
| 4 | 23.3 | 21.3 | 19.4 | 16.2 | 14.5 | 12.9 | 9.5 | 9.0 | 8.5 | 8.0 | 5.2 | 4.8 | 4.4 | 0.27 |
| 5 | 18.6 | 17.1 | 15.5 | 12.9 | 11.6 | 10.3 | 7.6 | 7.2 | 6.8 | 6.4 | 4.1 | 3.8 | 3.5 | 0.41 |
| 6 | 15.5 | 14.2 | 12.9 | 10.8 | 9.7 | 8.6 | 6.3 | 6.0 | 5.6 | 5.3 | 3.5 | 3.2 | 2.9 | 0.60 |
| 7 | 13.3 | 12.2 | 11.1 | 9.2 | 8.3 | 7.4 | 5.4 | 5.1 | 4.8 | 4.5 | 3.0 | 2.7 | 2.5 | 0.81 |
| 8 | 11.6 | 10.7 | 9.7 | 8.1 | 7.3 | 6.4 | 4.8 | 4.5 | 4.2 | 4.0 | 2.6 | 2.4 | 2.2 | 1.06 |
| 9 | 10.3 | 9.5 | 8.6 | 7.2 | 6.5 | 5.7 | 4.2 | 4.0 | 3.8 | 3.5 | | | | 1.34 |
| 10 | 9.3 | 8.5 | 7.7 | 6.5 | 5.8 | 5.2 | 3.8 | 3.6 | 3.4 | 3.2 | | | | 1.66 |
| 11 | 8.5 | 7.8 | 7.0 | 5.9 | 5.3 | 4.7 | | | | | | | | 2.00 |
| 12 | 7.8 | 7.1 | 6.5 | 5.4 | 4.8 | 4.3 | | | | | | | | 2.38 |
| 13 | 7.2 | 6.6 | 6.0 | | | | | | | | | | | 2.80 |
| 14 | 6.7 | 6.1 | 5.5 | | | | | | | | | | | 3.24 |

Loads above horizontal lines will produce maximum allowable shear in webs.
*Loads below* dotted lines will produce excessive deflections.
*For maximum* safe loads, see page 140.

# Structural Beams

## Allowable Uniform Loads in Pounds per Foot

### Safe Loads Include Weight of Beam

| Depth, Inches | Pounds per Foot | Span in Feet | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 30 |
| 24 | 115 | 26270 | 21710 | 18240 | 15550 | 13400 | 11680 | 10260 | 9090 | 8110 | 7280 | 6570 | 5960 | 5430 | 4970 | 4560 | 4200 | 3890 | 3600 | 3350 | 2920 |
| | 110 | 25630 | 21180 | 17800 | 15170 | 13080 | 11390 | 10010 | 8870 | 7910 | 7100 | 6410 | 5810 | 5300 | 4850 | 4450 | 4100 | 3790 | 3520 | 3270 | 2850 |
| | 105 | 24990 | 20650 | 17360 | 14790 | 12750 | 11110 | 9760 | 8650 | 7710 | 6920 | 6250 | 5670 | 5160 | 4720 | 4340 | 4000 | 3700 | 3430 | 3190 | 2780 |
| | 100 | 21150 | 17480 | 14690 | 12520 | 10790 | 9400 | 8260 | 7320 | 6530 | 5860 | 5290 | 4800 | 4370 | 4000 | 3670 | 3380 | 3130 | 2900 | 2700 | 2350 |
| | 95 | 20520 | 16960 | 14250 | 12150 | 10470 | 9120 | 8020 | 7100 | 6340 | 5690 | 5130 | 4650 | 4240 | 3880 | 3560 | 3280 | 3040 | 2820 | 2620 | 2280 |
| | 90 | 19900 | 16440 | 13820 | 11770 | 10150 | 8840 | 7770 | 6880 | 6140 | 5510 | 4970 | 4510 | 4110 | 3760 | 3450 | 3180 | 2940 | 2730 | 2540 | 2210 |
| | 85 | 19270 | 15930 | 13380 | 11400 | 9830 | 8560 | 7530 | 6670 | 5950 | 5340 | 4820 | 4370 | 3980 | 3640 | 3350 | 3080 | 2850 | 2640 | 2460 | 2140 |
| | 80 | 18550 | 15330 | 12880 | 10980 | 9470 | 8250 | 7250 | 6420 | 5730 | 5140 | 4640 | 4210 | 3830 | 3510 | 3220 | 2970 | 2750 | 2550 | 2370 | 2060 |
| 20 | 100 | 17660 | 14590 | 12260 | 10450 | 9010 | 7850 | 6900 | 6110 | 5450 | 4890 | 4420 | 4000 | 3650 | 3340 | 3070 | 2830 | 2610 | 2420 | 2250 | 1960 |
| | 95 | 17140 | 14160 | 11900 | 10140 | 8740 | 7620 | 6690 | 5930 | 5290 | 4750 | 4280 | 3890 | 3540 | 3240 | 2980 | 2740 | 2540 | 2350 | 2190 | 1900 |
| | 90 | 16610 | 13730 | 11540 | 9830 | 8480 | 7380 | 6490 | 5750 | 5130 | 4600 | 4150 | 3770 | 3430 | 3140 | 2880 | 2660 | 2460 | 2280 | 2120 | 1850 |
| | 85 | 16090 | 13300 | 11170 | 9520 | 8210 | 7150 | 6290 | 5570 | 4970 | 4460 | 4020 | 3650 | 3320 | 3040 | 2790 | 2570 | 2380 | 2210 | 2050 | 1790 |
| | 80 | 15640 | 12930 | 10860 | 9260 | 7980 | 6950 | 6110 | 5410 | 4830 | 4330 | 3910 | 3550 | 3230 | 2960 | 2720 | 2500 | 2310 | 2150 | 2000 | 1740 |
| | 75 | 13530 | 11180 | 9400 | 8010 | 6910 | 6020 | 5290 | 4680 | 4180 | 3750 | 3380 | 3070 | 2800 | 2560 | 2350 | 2170 | 2000 | 1860 | 1730 | 1500 |
| | 70 | 13010 | 10750 | 9040 | 7700 | 6640 | 5780 | 5080 | 4500 | 4020 | 3600 | 3250 | 2950 | 2690 | 2460 | 2260 | 2080 | 1920 | 1790 | 1660 | 1450 |
| | 65 | 12480 | 10310 | 8660 | 7380 | 6370 | 5440 | 4870 | 4320 | 3850 | 3460 | 3120 | 2830 | 2580 | 2360 | 2170 | 2000 | 1850 | 1710 | 1590 | 1390 |
| 18 | 90 | 14940 | 12350 | 10370 | 8840 | 7620 | 6640 | 5840 | 5170 | 4610 | 4130 | 3730 | 3390 | 3090 | 2820 | 2590 | 2390 | 2210 | 2050 | 1910 | 1660 |
| | 85 | 14470 | 11960 | 10050 | 8560 | 7380 | 6430 | 5650 | 5010 | 4470 | 4010 | 3620 | 3280 | 2990 | 2740 | 2510 | 2310 | 2140 | 1980 | 1850 | 1610 |
| | 80 | 14000 | 11570 | 9720 | 8280 | 7140 | 6220 | 5470 | 4840 | 4320 | 3880 | 3500 | 3170 | 2890 | 2650 | 2430 | 2240 | 2070 | 1920 | 1790 | 1560 |
| | 75 | 13530 | 11180 | 9390 | 8000 | 6900 | 6010 | 5280 | 4680 | 4180 | 3750 | 3380 | 3070 | 2800 | 2560 | 2350 | 2160 | 2000 | 1860 | 1730 | 1500 |
| | 70 | 10920 | 9020 | 7580 | 6460 | 5570 | 4850 | 4260 | 3780 | 3370 | 3020 | 2730 | 2480 | 2260 | 2060 | 1900 | 1750 | 1620 | 1500 | 1390 | 1210 |
| | 65 | 10450 | 8630 | 7260 | 6180 | 5330 | 4640 | 4080 | 3620 | 3220 | 2890 | 2610 | 2370 | 2160 | 1970 | 1810 | 1670 | 1550 | 1430 | 1330 | 1160 |
| | 60 | 9980 | 8250 | 6930 | 5900 | 5090 | 4430 | 3900 | 3450 | 3080 | 2760 | 2490 | 2260 | 2060 | 1890 | 1730 | 1600 | 1480 | 1370 | 1270 | 1110 |
| | 55 | 9430 | 7790 | 6550 | 5580 | 4810 | 4190 | 3680 | 3260 | 2910 | 2610 | 2330 | 2140 | 1950 | 1780 | 1640 | 1510 | 1400 | 1290 | 1200 | 1050 |

# Structural Beams

## Allowable Uniform Loads in Pounds per Foot

**Continued**

**Safe Loads Include Weight of Beam**

| Depth, Inches | Pounds per Foot | Span in Feet: 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 75 | 27310 | 20060 | 15360 | 12140 | 9830 | 8120 | 6830 | 5820 | 5020 | 4370 | 3840 | 3400 | 3030 | 2720 | 2460 | 2230 | 2030 | 1860 | 1710 | 1570 | 1450 |
| | 70 | 26220 | 19260 | 14750 | 11650 | 9440 | 7800 | 6550 | 5590 | 4820 | 4200 | 3690 | 3270 | 2910 | 2610 | 2360 | 2140 | 1950 | 1780 | 1640 | 1510 | 1400 |
| | 65 | 25130 | 18460 | 14140 | 11170 | 9050 | 7480 | 6280 | 5350 | 4620 | 4020 | 3530 | 3130 | 2790 | 2510 | 2260 | 2050 | 1870 | 1710 | 1570 | 1450 | 1340 |
| | 60 | 24060 | 17680 | 13530 | 10690 | 8660 | 7160 | 6010 | 5130 | 4420 | 3850 | 3380 | 3000 | 2670 | 2400 | 2170 | 1960 | 1790 | 1640 | 1500 | 1390 | 1280 |
| | 55 | 20190 | 14830 | 11360 | 8970 | 7270 | 6010 | 5050 | 4300 | 3710 | 3230 | 2840 | 2520 | 2240 | 2010 | 1820 | 1650 | 1500 | 1370 | 1260 | 1160 | 1080 |
| | 50 | 19100 | 14030 | 10740 | 8490 | 6880 | 5680 | 4780 | 4070 | 3510 | 3060 | 2690 | 2380 | 2120 | 1910 | 1720 | 1560 | 1420 | 1300 | 1190 | 1100 | 1020 |
| | 45 | 18010 | 13230 | 10130 | 8000 | 6480 | 5360 | 4500 | 3840 | 3310 | 2880 | 2530 | 2240 | 2000 | 1800 | 1620 | 1470 | 1340 | 1230 | 1130 | 1040 | 960 |
| | 42 | 17450 | 12820 | 9820 | 7760 | 6280 | 5190 | 4360 | 3720 | 3210 | 2790 | 2450 | 2170 | 1940 | 1740 | 1570 | 1430 | 1300 | 1190 | 1090 | 1010 | 930 |
| 12 | 55 | 15850 | 11650 | 8920 | 7050 | 5710 | 4720 | 3960 | 3380 | 2910 | 2540 | 2230 | 1980 | 1760 | 1580 | 1430 | 1290 | 1180 | 1080 | 990 | 910 | 840 |
| | 50 | 14980 | 11010 | 8430 | 6660 | 5390 | 4460 | 3750 | 3190 | 2750 | 2400 | 2110 | 1870 | 1660 | 1490 | 1350 | 1220 | 1110 | 1020 | 940 | 860 | 800 |
| | 45 | 14110 | 10370 | 7940 | 6270 | 5080 | 4200 | 3530 | 3010 | 2590 | 2260 | 1980 | 1760 | 1570 | 1410 | 1270 | 1150 | 1050 | 960 | 880 | 810 | 750 |
| | 40 | 13280 | 9760 | 7470 | 5900 | 4780 | 3950 | 3320 | 2830 | 2440 | 2130 | 1870 | 1650 | 1480 | 1320 | 1200 | 1080 | 990 | 900 | 830 | 770 | 710 |
| | 35 | 11270 | 8280 | 6340 | 5010 | 4060 | 3350 | 2820 | 2400 | 2070 | 1800 | 1580 | 1400 | 1250 | 1120 | 1020 | 920 | 840 | 770 | 700 | 650 | 600 |
| | 31.5 | 10660 | 7830 | 6000 | 4740 | 3840 | 3170 | 2660 | 2270 | 1960 | 1710 | 1500 | 1330 | 1180 | 1060 | 960 | 870 | 790 | 730 | 670 | 610 | 570 |
| 10 | 40 | 9400 | 6910 | 5290 | 4180 | 3390 | 2800 | 2350 | 2000 | 1730 | 1500 | 1320 | 1170 | 1040 | 940 | 850 | 770 | 700 | | | | |
| | 35 | 8680 | 6380 | 4880 | 3860 | 3120 | 2580 | 2170 | 1850 | 1590 | 1390 | 1220 | 1080 | 960 | 870 | 780 | 710 | 650 | | | | |
| | 30 | 7950 | 5840 | 4470 | 3530 | 2860 | 2370 | 1990 | 1690 | 1460 | 1270 | 1120 | 990 | 880 | 790 | 720 | 650 | 590 | | | | |
| | 25 | 7240 | 5320 | 4070 | 3220 | 2610 | 2150 | 1810 | 1540 | 1330 | 1160 | 1020 | 900 | 800 | 720 | 650 | 590 | 540 | | | | |
| 9 | 35 | 7360 | 5410 | 4140 | 3270 | 2650 | 2190 | 1840 | 1570 | 1350 | 1180 | 1040 | 920 | 820 | 730 | 660 | | | | | | |
| | 30 | 6710 | 4930 | 3770 | 2980 | 2420 | 2000 | 1680 | 1430 | 1230 | 1070 | 940 | 840 | 750 | 670 | 600 | | | | | | |
| | 25 | 6050 | 4450 | 3410 | 2690 | 2180 | 1800 | 1510 | 1290 | 1110 | 970 | 850 | 750 | 670 | 600 | 540 | | | | | | |
| | 21 | 5590 | 4110 | 3150 | 2490 | 2010 | 1660 | 1400 | 1190 | 1030 | 900 | 790 | 700 | 620 | 560 | 500 | | | | | | |

Loads below dotted lines will produce excessive deflection.

# Structural Beams

## Allowable Uniform Loads in Pounds per Foot

**Continued**

**Safe Loads Include Weight of Beam**

| Depth, Inches | Pounds per Foot | Span in Feet: 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 25.5 | 43280 | 29200 | 20280 | 14900 | 11410 | 9010 | 7300 | 6030 | 5070 | 4320 | 3720 | 2850 | 2250 | 1830 | 1510 | 1270 | 1080 | 930 | 810 | 710 | 630 | 560 |
| | 23. | 35920 | 27520 | 19110 | 14040 | 10750 | 8490 | 6880 | 5690 | 4780 | 4070 | 3510 | 2690 | 2120 | 1720 | 1420 | 1190 | 1020 | 880 | 760 | 670 | 600 | 530 |
| | 20.5 | 28560 | 22840 | 17950 | 13190 | 10100 | 7980 | 6460 | 5340 | 4490 | 3820 | 3300 | 2520 | 1990 | 1620 | 1340 | 1120 | 960 | 820 | 720 | 630 | 560 | 500 |
| | 18. | 21600 | 17280 | 14400 | 12340 | 9480 | 7490 | 6070 | 5010 | 4210 | 3590 | 3100 | 2370 | 1870 | 1520 | 1250 | 1050 | 900 | 770 | 670 | 590 | 530 | 470 |
| 7 | 20. | 32060 | 20570 | 14280 | 10490 | 8040 | 6350 | 5140 | 4250 | 3570 | 3040 | 2620 | 2010 | 1590 | 1290 | 1060 | 890 | 760 | 660 | 570 | 500 | | |
| | 17.5 | 24710 | 19100 | 13270 | 9750 | 7460 | 5900 | 4780 | 3950 | 3320 | 2830 | 2440 | 1870 | 1470 | 1190 | 990 | 830 | 710 | 610 | 530 | 470 | | |
| | 15. | 17500 | 14000 | 11700 | 9010 | 6900 | 5450 | 4420 | 3650 | 3070 | 2610 | 2250 | 1730 | 1360 | 1100 | 910 | 770 | 650 | 560 | 490 | 430 | | |
| 6 | 17.25 | 23280 | 14900 | 10350 | 7600 | 5820 | 4600 | 3720 | 3080 | 2590 | 2200 | 1900 | 1450 | 1150 | 930 | 770 | 650 | 550 | 480 | | | | |
| | 14.75 | 21120 | 13650 | 9470 | 6960 | 5330 | 4210 | 3410 | 2820 | 2370 | 2020 | 1740 | 1330 | 1050 | 850 | 700 | 590 | 500 | 440 | | | | |
| | 12.25 | 13800 | 11040 | 8610 | 6320 | 4840 | 3830 | 3100 | 2560 | 2150 | 1830 | 1580 | 1210 | 960 | 780 | 640 | 540 | 460 | 400 | | | | |
| 5 | 14.75 | 16160 | 10340 | 7180 | 5280 | 4040 | 3190 | 2590 | 2140 | 1800 | 1530 | 1320 | 1010 | 800 | 650 | 530 | 450 | | | | | | |
| | 12.25 | 14530 | 9300 | 6460 | 4740 | 3630 | 2870 | 2320 | 1920 | 1610 | 1380 | 1190 | 910 | 720 | 580 | 480 | 400 | | | | | | |
| | 9.75 | 10500 | 8250 | 5730 | 4210 | 3220 | 2550 | 2060 | 1710 | 1430 | 1220 | 1050 | 810 | 640 | 520 | 430 | 360 | | | | | | |
| 4 | 10.5 | 9520 | 6090 | 4230 | 3110 | 2380 | 1880 | 1520 | 1260 | 1060 | 900 | 780 | 590 | 470 | 380 | | | | | | | | |
| | 9.5 | 9000 | 5760 | 4000 | 2940 | 2250 | 1780 | 1440 | 1190 | 1000 | 850 | 730 | 560 | 440 | 360 | | | | | | | | |
| | 8.5 | 8470 | 5420 | 3770 | 2770 | 2120 | 1670 | 1360 | 1120 | 940 | 800 | 690 | 530 | 420 | 340 | | | | | | | | |
| | 7.5 | 7600 | 5090 | 3530 | 2600 | 1990 | 1570 | 1270 | 1050 | 880 | 750 | 650 | 500 | 390 | 320 | | | | | | | | |
| 3 | 7.5 | 5180 | 3310 | 2300 | 1690 | 1290 | 1020 | 830 | 680 | 580 | 490 | 420 | | | | | | | | | | | |
| | 6.5 | 4780 | 3060 | 2130 | 1560 | 1200 | 940 | 770 | 630 | 530 | 450 | 390 | | | | | | | | | | | |
| | 5.5 | 4410 | 2820 | 1960 | 1440 | 1100 | 870 | 710 | 580 | 490 | 420 | 360 | | | | | | | | | | | |

Loads within heavy lines will produce excessive shear in webs.
Loads below dotted lines will produce excessive deflections.

# Structural Channels

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**

**Safe Loads Include Weight of Channel**

| Span in Feet | Depth and Weight of Sections | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|
| | 15 Inch | | | | | | |
| | 55 lbs. | 50 lbs. | 45 lbs. | 40 lbs. | 35 lbs. | 33 lbs. | |
| | 245.4 | 216.0 | 186.6 | | | | |
| 3 | 204.0 | 190.9 | 177.8 | 157.2 | 127.8 | 120.0 | 0.15 |
| 4 | 153.0 | 143.2 | 133.4 | 123.6 | 113.8 | 111.1 | 0.27 |
| 5 | 122.4 | 114.5 | 106.7 | 98.9 | 91.0 | 88.9 | 0.41 |
| 6 | 102.0 | 95.4 | 88.9 | 82.4 | 75.8 | 74.1 | 0.60 |
| 7 | 87.4 | 81.8 | 76.2 | 70.6 | 65.0 | 63.5 | 0.81 |
| 8 | 76.5 | 71.6 | 66.7 | 61.8 | 56.9 | 55.6 | 1.06 |
| 9 | 68.0 | 63.6 | 59.3 | 54.9 | 50.6 | 49.4 | 1.34 |
| 10 | 61.2 | 57.3 | 53.3 | 49.4 | 45.5 | 44.5 | 1.66 |
| 11 | 55.6 | 52.1 | 48.5 | 44.9 | 41.4 | 40.4 | 2.00 |
| 12 | 51.0 | 47.7 | 44.5 | 41.2 | 37.9 | 37.0 | 2.38 |
| 13 | 47.1 | 44.1 | 41.0 | 38.0 | 35.0 | 34.2 | 2.80 |
| 14 | 43.7 | 40.9 | 38.1 | 35.3 | 32.5 | 31.8 | 3.24 |
| 15 | 40.8 | 38.2 | 35.6 | 33.0 | 30.3 | 29.6 | 3.72 |
| 16 | 38.2 | 35.8 | 33.3 | 30.9 | 28.4 | 27.8 | 4.24 |
| 17 | 36.0 | 33.7 | 31.4 | 29.1 | 26.8 | 26.1 | 4.78 |
| 18 | 34.0 | 31.8 | 29.6 | 27.5 | 25.3 | 24.7 | 5.36 |
| 19 | 32.2 | 30.1 | 28.1 | 26.0 | 23.9 | 23.4 | 5.98 |
| 20 | 30.6 | 28.6 | 26.7 | 24.7 | 22.8 | 22.3 | 6.62 |
| 21 | 29.1 | 27.3 | 25.4 | 23.5 | 21.7 | 21.2 | 7.30 |
| 22 | 27.8 | 26.0 | 24.3 | 22.5 | 20.7 | 20.2 | 8.01 |
| 23 | 26.6 | 24.9 | 23.2 | 21.5 | 19.8 | 19.3 | 8.76 |
| 24 | 25.5 | 23.9 | 22.2 | 20.6 | 19.0 | 18.5 | 9.53 |
| 25 | 24.5 | 22.9 | 21.3 | 19.8 | 18.2 | 17.8 | 10.35 |
| 26 | 23.5 | 22.0 | 20.5 | 19.0 | 17.5 | 17.1 | 11.19 |
| 27 | 22.7 | 21.2 | 19.8 | 18.3 | 16.9 | 16.5 | 12.07 |
| 28 | 21.9 | 20.5 | 19.1 | 17.7 | 16.3 | 15.9 | 12.98 |
| 29 | 21.1 | 19.7 | 18.4 | 17.0 | 15.7 | 15.3 | 13.92 |
| 30 | 20.4 | 19.1 | 17.8 | 16.5 | 15.2 | 14.8 | 14.90 |
| 31 | 19.7 | 18.5 | 17.2 | 15.9 | 14.7 | 14.3 | 15.91 |
| 32 | 19.1 | 17.9 | 16.7 | 15.4 | 14.2 | 13.9 | 16.95 |

Loads above horizontal lines will produce maximum allowable shear in webs.
Loads below dotted lines will produce excessive deflections.

# Structural Channels

## Allowable Uniform Loads in Thousands of Pounds

### Continued

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Channel**

| Span in Feet | Depth and Weight of Sections: 12 Inch | | | | | 10 Inch | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 lbs. | 35 lbs. | 30 lbs. | 25 lbs. | 20½ lbs. | 35 lbs. | 30 lbs. | 25 lbs. | 20 lbs. | 15 lbs. | |
| | 181.9 | | | | | 164.6 | 135.2 | 105.8 | | | |
| 2 | 175.1 | 152.6 | 123.1 | 93.6 | | 123.2 | 110.1 | 97.0 | 76.4 | 48.0 | 0.07 |
| 3 | 116.7 | 106.2 | 95.8 | 85.3 | 67.2 | 82.1 | 73.4 | 64.7 | 56.0 | 47.6 | 0.15 |
| 4 | 87.5 | 79.7 | 71.8 | 64.0 | 56.9 | 61.6 | 55.1 | 48.5 | 42.0 | 35.7 | 0.27 |
| 5 | 70.0 | 63.7 | 57.5 | 51.2 | 45.5 | 49.3 | 44.0 | 38.8 | 33.6 | 28.5 | 0.41 |
| 6 | 58.4 | 53.1 | 47.9 | 42.7 | 38.0 | 41.1 | 36.7 | 32.3 | 28.0 | 23.8 | 0.60 |
| 7 | 50.0 | 45.5 | 41.1 | 36.6 | 32.5 | 35.2 | 31.5 | 27.7 | 24.0 | 20.4 | 0.81 |
| 8 | 43.8 | 39.8 | 35.9 | 32.0 | 28.5 | 30.8 | 27.5 | 24.3 | 21.0 | 17.8 | 1.06 |
| 9 | 38.9 | 35.4 | 31.9 | 28.4 | 25.3 | 27.4 | 24.5 | 21.6 | 18.7 | 15.9 | 1.34 |
| 10 | 35.0 | 31.9 | 28.7 | 25.6 | 22.8 | 24.6 | 22.0 | 19.4 | 16.8 | 14.3 | 1.66 |
| 11 | 31.8 | 29.0 | 26.1 | 23.3 | 20.7 | 22.4 | 20.0 | 17.6 | 15.3 | 13.0 | 2.00 |
| 12 | 29.2 | 26.6 | 23.9 | 21.3 | 19.0 | 20.5 | 18.4 | 16.2 | 14.0 | 11.9 | 2.38 |
| 13 | 26.9 | 24.5 | 22.1 | 19.7 | 17.5 | 19.0 | 16.9 | 14.9 | 12.9 | 11.0 | 2.80 |
| 14 | 25.0 | 22.8 | 20.5 | 18.3 | 16.3 | 17.6 | 15.7 | 13.9 | 12.0 | 10.2 | 3.24 |
| 15 | 23.3 | 21.2 | 19.2 | 17.1 | 15.2 | 16.4 | 14.7 | 12.9 | 11.2 | 9.5 | 3.72 |
| 16 | 21.9 | 19.9 | 18.0 | 16.0 | 14.2 | 15.4 | 13.8 | 12.1 | 10.5 | 8.9 | 4.24 |
| 17 | 20.6 | 18.7 | 16.9 | 15.1 | 13.4 | 14.5 | 13.0 | 11.4 | 9.9 | 8.4 | 4.78 |
| 18 | 19.5 | 17.7 | 16.0 | 14.2 | 12.7 | 13.7 | 12.2 | 10.8 | 9.3 | 7.9 | 5.36 |
| 19 | 18.4 | 16.8 | 15.1 | 13.5 | 12.0 | 13.0 | 11.6 | 10.2 | 8.8 | 7.5 | 5.98 |
| 20 | 17.5 | 15.9 | 14.4 | 12.8 | 11.4 | 12.3 | 11.0 | 9.7 | 8.4 | 7.1 | 6.62 |
| 21 | 16.7 | 15.2 | 13.7 | 12.2 | 10.8 | 11.7 | 10.5 | 9.2 | 8.0 | 6.8 | 7.30 |
| 22 | 15.9 | 14.5 | 13.1 | 11.6 | 10.4 | 11.2 | 10.0 | 8.8 | 7.6 | 6.5 | 8.01 |
| 23 | 15.2 | 13.9 | 12.5 | 11.1 | 9.9 | | | | | | 8.76 |
| 24 | 14.6 | 13.3 | 12.0 | 10.7 | 9.5 | | | | | | 9.53 |
| 25 | 14.0 | 12.8 | 11.5 | 10.2 | 9.1 | | | | | | 10.35 |
| 26 | 13.5 | 12.3 | 11.1 | 9.8 | 8.8 | | | | | | 11.19 |

Loads above horizontal lines will produce maximum allowable shear in webs.
Loads below dotted lines will produce excessive deflections.

# Structural Channels

## Allowable Uniform Loads in Thousands of Pounds

### Continued

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Channel**

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9 Inch | | | | 8 Inch | | | | | 7 Inch | | | | | |
| | 25 lbs. | 20 lbs. | 15 lbs. | 13¼ lbs. | 21¼ lbs. | 18¾ lbs. | 16¼ lbs. | 13¾ lbs. | 11¼ lbs. | 19¾ lbs. | 17¼ lbs. | 14¾ lbs. | 12¼ lbs. | 9¾ lbs. | |
| | 110.7 | 81.4 | | | 93.1 | 78.4 | 63.8 | 49.1 | | 88.6 | 73.9 | 59.2 | 44.5 | | |
| 2 | 83.8 | 72.0 | 51.8 | 41.4 | 63.7 | 58.5 | 53.2 | 48.0 | 35.2 | 50.6 | 46.0 | 41.4 | 36.8 | 29.4 | 0.07 |
| 3 | 55.9 | 48.0 | 40.2 | 37.4 | 42.5 | 39.0 | 35.5 | 32.0 | 28.7 | 33.7 | 30.7 | 27.6 | 24.6 | 21.4 | 0.15 |
| 4 | 41.9 | 36.0 | 30.1 | 28.0 | 31.8 | 29.2 | 26.6 | 24.0 | 21.5 | 25.3 | 23.0 | 20.7 | 18.4 | 16.1 | 0.27 |
| 5 | 33.5 | 28.8 | 24.1 | 22.4 | 25.5 | 23.4 | 21.3 | 19.2 | 17.2 | 20.2 | 18.4 | 16.6 | 14.7 | 12.9 | 0.41 |
| 6 | 27.9 | 24.0 | 20.1 | 18.7 | 21.2 | 19.5 | 17.7 | 16.0 | 14.4 | 16.9 | 15.3 | 13.8 | 12.3 | 10.7 | 0.60 |
| 7 | 23.9 | 20.6 | 17.2 | 16.0 | 18.2 | 16.7 | 15.2 | 13.7 | 12.3 | 14.4 | 13.1 | 11.8 | 10.5 | 9.2 | 0.81 |
| 8 | 20.9 | 18.0 | 15.1 | 14.0 | 15.9 | 14.6 | 13.3 | 12.0 | 10.8 | 12.6 | 11.5 | 10.4 | 9.2 | 8.0 | 1.06 |
| 9 | 18.6 | 16.0 | 13.4 | 12.5 | 14.2 | 13.0 | 11.8 | 10.7 | 9.6 | 11.2 | 10.2 | 9.2 | 8.2 | 7.1 | 1.34 |
| 10 | 16.8 | 14.4 | 12.1 | 11.2 | 12.7 | 11.7 | 10.6 | 9.6 | 8.6 | 10.1 | 9.2 | 8.3 | 7.4 | 6.4 | 1.66 |
| 11 | 15.2 | 13.1 | 11.0 | 10.2 | 11.6 | 10.6 | 9.7 | 8.7 | 7.8 | 9.2 | 8.4 | 7.5 | 6.7 | 5.8 | 2.00 |
| 12 | 14.0 | 12.0 | 10.1 | 9.3 | 10.6 | 9.7 | 8.9 | 8.0 | 7.2 | 8.4 | 7.7 | 6.9 | 6.1 | 5.4 | 2.38 |
| 13 | 12.9 | 11.1 | 9.3 | 8.6 | 9.8 | 9.0 | 8.2 | 7.4 | 6.6 | 7.8 | 7.1 | 6.4 | 5.7 | 4.9 | 2.80 |
| 14 | 12.0 | 10.3 | 8.6 | 8.0 | 9.1 | 8.4 | 7.6 | 6.9 | 6.2 | 7.2 | 6.6 | 5.9 | 5.3 | 4.6 | 3.24 |
| 15 | 11.2 | 9.6 | 8.0 | 7.5 | 8.5 | 7.8 | 7.1 | 6.4 | 5.7 | 6.7 | 6.1 | 5.5 | 4.9 | 4.3 | 3.72 |
| 16 | 10.5 | 9.0 | 7.5 | 7.0 | 8.0 | 7.3 | 6.7 | 6.0 | 5.4 | 6.3 | 5.7 | 5.2 | 4.6 | 4.0 | 4.24 |
| 17 | 9.9 | 8.5 | 7.1 | 6.6 | 7.5 | 6.9 | 6.3 | 5.6 | 5.1 | | | | | | 4.78 |
| 18 | 9.3 | 8.0 | 6.7 | 6.2 | 7.1 | 6.5 | 5.9 | 5.3 | 4.8 | | | | | | 5.36 |
| 19 | 8.8 | 7.6 | 6.3 | 5.9 | | | | | | | | | | | 5.98 |
| 20 | 8.4 | 7.2 | 6.0 | 5.6 | | | | | | | | | | | 6.62 |

| Span in Feet | Depth and Weight of Sections | | | | | | | | | | | | | Coefficient of Deflection |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 Inch | | | | 5 Inch | | | 4 Inch | | | 3 Inch | | | |
| | 15½ lbs. | 13 lbs. | 10½ lbs. | 8 lbs. | 11½ lbs. | 9 lbs. | 6½ lbs. | 7¼ lbs. | 6¼ lbs. | 5¼ lbs. | 6 lbs. | 5 lbs. | 4 lbs. | |
| | | | | | 47.7 | | | 26.0 | | | 21.7 | 15.8 | | |
| 1 | 67.6 | 52.8 | 38.2 | 24.0 | 44.4 | 33.0 | 19.0 | 24.4 | 20.2 | 14.4 | 14.7 | 13.1 | 10.2 | 0.02 |
| 2 | 34.7 | 30.8 | 26.9 | 23.1 | 22.2 | 18.9 | 15.8 | 12.2 | 11.1 | 10.1 | 7.4 | 6.6 | 5.8 | 0.07 |
| 3 | 23.2 | 20.5 | 17.9 | 15.4 | 14.8 | 12.6 | 10.5 | 8.1 | 7.4 | 6.7 | 4.9 | 4.4 | 3.9 | 0.15 |
| 4 | 17.4 | 15.4 | 13.4 | 11.6 | 11.1 | 9.5 | 7.9 | 6.1 | 5.6 | 5.1 | 3.7 | 3.3 | 2.9 | 0.27 |
| 5 | 13.9 | 12.3 | 10.8 | 9.2 | 8.9 | 7.6 | 6.3 | 4.9 | 4.5 | 4.1 | 2.9 | 2.6 | 2.3 | 0.41 |
| 6 | 11.6 | 10.3 | 9.0 | 7.7 | 7.4 | 6.3 | 5.3 | 4.1 | 3.7 | 3.4 | 2.5 | 2.2 | 1.9 | 0.60 |
| 7 | 9.9 | 8.8 | 7.7 | 6.6 | 6.3 | 5.4 | 4.5 | 3.5 | 3.2 | 2.9 | 2.1 | 1.9 | 1.7 | 0.81 |
| 8 | 8.7 | 7.7 | 6.7 | 5.8 | 5.5 | 4.7 | 4.0 | 3.0 | 2.8 | 2.5 | 1.8 | 1.6 | 1.5 | 1.06 |
| 9 | 7.7 | 6.8 | 6.0 | 5.1 | 4.9 | 4.2 | 3.5 | 2.7 | 2.5 | 2.2 | | | | 1.34 |
| 10 | 6.9 | 6.2 | 5.4 | 4.6 | 4.4 | 3.8 | 3.2 | 2.4 | 2.2 | 2.0 | | | | 1.66 |
| 11 | 6.3 | 5.6 | 4.9 | 4.2 | 4.0 | 3.4 | 2.9 | | | | | | | 2.00 |
| 12 | 5.8 | 5.1 | 4.5 | 3.9 | 3.7 | 3.2 | 2.6 | | | | | | | 2.38 |
| 13 | 5.3 | 4.7 | 4.1 | 3.6 | | | | | | | | | | 2.80 |
| 14 | 5.0 | 4.4 | 3.8 | 3.3 | | | | | | | | | | 3.24 |

Loads above horizontal lines will produce maximum allowable shear in webs.
*Loads below dotted* lines will produce excessive deflections.

# Structural Channels

## Allowable Uniform Loads in Pounds per Foot

### Safe Loads Include Weight of Channel

| Depth, Inches | Pounds per Foot | Span in Feet 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 55 | 17000 | 12490 | 9560 | 7550 | 6120 | 5060 | 4250 | 3620 | 3120 | 2720 | 2390 | 2120 | 1890 | 1690 | 1530 | 1390 | 1260 | 1160 | 1060 | 980 | 910 |
| | 50 | 15910 | 11690 | 8950 | 7070 | 5730 | 4730 | 3980 | 3390 | 2920 | 2550 | 2240 | 1980 | 1770 | 1590 | 1430 | 1300 | 1180 | 1080 | 990 | 920 | 850 |
| | 45 | 14820 | 10890 | 8340 | 6590 | 5330 | 4410 | 3700 | 3160 | 2720 | 2370 | 2080 | 1850 | 1650 | 1480 | 1330 | 1210 | 1100 | 1010 | 930 | 850 | 790 |
| | 40 | 13730 | 10090 | 7720 | 6100 | 4940 | 4080 | 3430 | 2920 | 2520 | 2200 | 1930 | 1710 | 1530 | 1370 | 1240 | 1120 | 1020 | 930 | 860 | 790 | 730 |
| | 35 | 12640 | 9290 | 7110 | 5620 | 4550 | 3760 | 3160 | 2690 | 2320 | 2020 | 1780 | 1570 | 1400 | 1260 | 1140 | 1030 | 940 | 860 | 790 | 730 | 670 |
| | 33 | 12350 | 9070 | 6950 | 5490 | 4450 | 3670 | 3090 | 2630 | 2270 | 1980 | 1740 | 1540 | 1370 | 1230 | 1110 | 1010 | 920 | 840 | 770 | 710 | 660 |
| 12 | 40 | 9730 | 7150 | 5470 | 4320 | 3500 | 2890 | 2430 | 2070 | 1790 | 1560 | 1370 | 1210 | 1080 | 970 | 880 | 790 | 720 | 660 | 610 | 560 | 520 |
| | 35 | 8850 | 6500 | 4980 | 3940 | 3190 | 2630 | 2210 | 1890 | 1630 | 1420 | 1250 | 1100 | 980 | 880 | 800 | 720 | 660 | 600 | 550 | 510 | 470 |
| | 30 | 7980 | 5860 | 4490 | 3550 | 2870 | 2380 | 2000 | 1700 | 1470 | 1280 | 1120 | 1000 | 890 | 800 | 720 | 650 | 590 | 540 | 500 | 460 | 430 |
| | 25 | 7110 | 5220 | 4000 | 3160 | 2560 | 2120 | 1780 | 1520 | 1310 | 1140 | 1000 | 890 | 790 | 710 | 640 | 580 | 530 | 480 | 440 | 410 | 380 |
| | 20.5 | 6330 | 4650 | 3560 | 2810 | 2280 | 1880 | 1580 | 1350 | 1160 | 1010 | 890 | 780 | 700 | 630 | 570 | 520 | 470 | 430 | 400 | 360 | 340 |
| 10 | 35 | 6840 | 5030 | 3850 | 3040 | 2460 | 2040 | 1710 | 1460 | 1260 | 1100 | 960 | 850 | 760 | 680 | 620 | 560 | 510 | | | | |
| | 30 | 6120 | 4490 | 3440 | 2720 | 2200 | 1820 | 1530 | 1300 | 1120 | 980 | 860 | 760 | 680 | 610 | 550 | 500 | 460 | | | | |
| | 25 | 5390 | 3960 | 3030 | 2400 | 1940 | 1600 | 1350 | 1150 | 990 | 860 | 760 | 670 | 600 | 540 | 490 | 440 | 400 | | | | |
| | 20 | 4670 | 3430 | 2620 | 2070 | 1680 | 1390 | 1170 | 990 | 860 | 750 | 660 | 580 | 520 | 470 | 420 | 380 | 350 | | | | |
| | 15 | 3960 | 2910 | 2230 | 1760 | 1430 | 1180 | 990 | 840 | 730 | 630 | 560 | 490 | 440 | 400 | 360 | 320 | 290 | | | | |
| 9 | 25 | 4660 | 3420 | 2620 | 2070 | 1680 | 1390 | 1160 | 990 | 860 | 750 | 650 | 580 | 520 | 460 | 420 | | | | | | |
| | 20 | 4000 | 2940 | 2250 | 1780 | 1440 | 1190 | 1000 | 850 | 740 | 640 | 560 | 500 | 450 | 400 | 360 | | | | | | |
| | 15 | 3350 | 2460 | 1880 | 1490 | 1210 | 1000 | 840 | 710 | 620 | 540 | 470 | 420 | 370 | 330 | 300 | | | | | | |
| | 13.25 | 3120 | 2290 | 1750 | 1380 | 1120 | 930 | 780 | 660 | 570 | 500 | 440 | 390 | 350 | 310 | 280 | | | | | | |

Loads below dotted lines will produce excessive deflections.

# Structural Channels

## Allowable Uniform Loads in Pounds per Foot

### Continued

**Safe Loads Include Weight of Channel**

| Depth, Inches | Pounds per Foot | Span in Feet: 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 21.25 | 31840 | 20380 | 14150 | 10400 | 7960 | 6290 | 5090 | 4210 | 3540 | 3010 | 2600 | 1990 | 1570 | 1270 | 1050 | 880 | 750 | 650 | 570 | 500 | 440 | 390 |
| | 18.75 | 29230 | 18710 | 12990 | 9540 | 7310 | 5770 | 4680 | 3860 | 3250 | 2770 | 2390 | 1830 | 1440 | 1170 | 970 | 810 | 690 | 600 | 520 | 460 | 410 | 360 |
| | 16.25 | 26610 | 17030 | 11830 | 8690 | 6650 | 5260 | 4260 | 3520 | 2960 | 2520 | 2170 | 1660 | 1310 | 1060 | 880 | 740 | 630 | 540 | 470 | 420 | 370 | 330 |
| | 13.75 | 24000 | 15360 | 10670 | 7840 | 6000 | 4740 | 3840 | 3170 | 2670 | 2270 | 1960 | 1500 | 1190 | 960 | 790 | 670 | 570 | 490 | 430 | 370 | 330 | 300 |
| | 11.25 | 17600 | 13780 | 9570 | 7030 | 5380 | 4250 | 3450 | 2850 | 2390 | 2040 | 1760 | 1350 | 1060 | 860 | 710 | 600 | 510 | 440 | 380 | 340 | 300 | 270 |
| 7 | 19.75 | 25280 | 16180 | 11230 | 8250 | 6320 | 4990 | 4040 | 3340 | 2810 | 2390 | 2060 | 1580 | 1250 | 1010 | 840 | 700 | 600 | 520 | 450 | 400 | | |
| | 17.25 | 22990 | 14710 | 10220 | 7510 | 5750 | 4540 | 3680 | 3040 | 2550 | 2180 | 1880 | 1440 | 1140 | 920 | 760 | 640 | 540 | 470 | 410 | 360 | | |
| | 14.75 | 20700 | 13250 | 9200 | 6760 | 5180 | 4090 | 3310 | 2740 | 2300 | 1960 | 1690 | 1290 | 1020 | 830 | 680 | 580 | 490 | 420 | 370 | 320 | | |
| | 12.25 | 18410 | 11780 | 8180 | 6010 | 4600 | 3640 | 2950 | 2430 | 2050 | 1740 | 1500 | 1150 | 910 | 740 | 610 | 510 | 440 | 380 | 330 | 290 | | |
| | 9.75 | 14700 | 10280 | 7140 | 5250 | 4020 | 3170 | 2570 | 2120 | 1790 | 1520 | 1310 | 1000 | 790 | 640 | 530 | 450 | 380 | 330 | 290 | 250 | | |
| 6 | 15.5 | 17360 | 11110 | 7720 | 5670 | 4340 | 3430 | 2780 | 2300 | 1930 | 1640 | 1420 | 1090 | 860 | 690 | 570 | 480 | 410 | 350 | | | | |
| | 13.0 | 15400 | 9860 | 6840 | 5030 | 3850 | 3040 | 2460 | 2040 | 1710 | 1460 | 1260 | 960 | 760 | 620 | 510 | 430 | 360 | 310 | | | | |
| | 10.5 | 13440 | 8600 | 5970 | 4390 | 3360 | 2650 | 2150 | 1780 | 1490 | 1270 | 1100 | 840 | 660 | 540 | 440 | 370 | 320 | 270 | | | | |
| | 8.0 | 11550 | 7390 | 5130 | 3770 | 2890 | 2280 | 1850 | 1530 | 1280 | 1090 | 940 | 720 | 570 | 460 | 380 | 320 | 270 | 240 | | | | |
| 5 | 11.5 | 11100 | 7100 | 4930 | 3620 | 2770 | 2190 | 1780 | 1470 | 1230 | 1050 | 910 | 690 | 550 | 440 | 370 | 310 | | | | | | |
| | 9.0 | 9460 | 6060 | 4210 | 3090 | 2370 | 1870 | 1510 | 1250 | 1050 | 900 | 770 | 590 | 470 | 380 | 310 | 260 | | | | | | |
| | 6.5 | 7910 | 5060 | 3520 | 2580 | 1980 | 1560 | 1270 | 1050 | 880 | 750 | 650 | 490 | 390 | 320 | 260 | 220 | | | | | | |
| 4 | 7.25 | 6090 | 3900 | 2710 | 1990 | 1520 | 1200 | 980 | 810 | 680 | 580 | 500 | 380 | 300 | 240 | | | | | | | | |
| | 6.25 | 5570 | 3570 | 2480 | 1820 | 1390 | 1100 | 890 | 740 | 620 | 530 | 460 | 350 | 280 | 220 | | | | | | | | |
| | 5.25 | 5060 | 3240 | 2250 | 1650 | 1260 | 1000 | 810 | 670 | 560 | 480 | 410 | 320 | 250 | 200 | | | | | | | | |
| 3 | 6.0 | 3680 | 2350 | 1630 | 1200 | 920 | 730 | 590 | 490 | 410 | 350 | 300 | | | | | | | | | | | |
| | 5.0 | 3290 | 2100 | 1460 | 1070 | 820 | 650 | 530 | 430 | 370 | 310 | 270 | | | | | | | | | | | |
| | 4.0 | 2910 | 1860 | 1290 | 950 | 730 | 570 | 470 | 380 | 320 | 280 | 240 | | | | | | | | | | | |

Loads within heavy lines will produce excessive shear in web.

Loads below dotted lines will produce excessive deflections.

# Angles with Equal Legs

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Angle**
**Neutral Axis Through Center of**
**Gravity Parallel to One Leg**

| Size of Angle, Inches | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8 x 8 x 1⅛ | 186.98 | 93.48 | 62.32 | 46.74 | 37.40 | 31.16 | 26.72 | 23.38 | 20.78 | 18.70 |
| 8 x 8 x ½ | 89.28 | 44.64 | 29.76 | 22.32 | 17.86 | 14.88 | 12.76 | 11.16 | 9.92 | 8.92 |
| 6 x 6 x 1 | 91.41 | 45.71 | 30.47 | 22.85 | 18.28 | 15.26 | 13.06 | 11.43 | 10.16 | 9.14 |
| 6 x 6 x ⅜ | 37.65 | 18.83 | 12.55 | 9.41 | 7.53 | 6.28 | 5.38 | 4.71 | 4.18 | 3.77 |
| 5 x 5 x 15/16 | 58.56 | 29.28 | 19.52 | 14.64 | 11.71 | 9.76 | 8.36 | 7.32 | 6.51 | 5.86 |
| 5 x 5 x ⅜ | 25.81 | 12.90 | 8.60 | 6.45 | 5.16 | 4.30 | 3.69 | 3.23 | 2.87 | 2.58 |
| 4 x 4 x 13/16 | 32.12 | 16.06 | 10.71 | 8.03 | 6.42 | 5.35 | 4.59 | 4.02 | 3.57 | 3.21 |
| 4 x 4 x ¼ | 11.20 | 5.60 | 3.73 | 2.80 | 2.24 | 1.87 | 1.60 | 1.40 | 1.24 | 1.12 |
| 3½ x 3½ x ¾ | 22.51 | 11.26 | 7.50 | 5.63 | 4.50 | 3.75 | 3.22 | 2.81 | 2.50 | 2.25 |
| 3½ x 3½ x ¼ | 8.43 | 4.22 | 2.81 | 2.11 | 1.68 | 1.41 | 1.20 | 1.05 | 0.94 | 0.84 |
| 3 x 3 x ⅝ | 13.87 | 6.94 | 4.62 | 3.47 | 2.77 | 2.31 | 1.98 | 1.73 | 1.54 | 1.39 |
| 3 x 3 x 3/16 | 6.18 | 3.09 | 2.06 | 1.54 | 1.24 | 1.03 | 0.88 | 0.77 | 0.69 | 0.62 |
| 2½ x 2½ x ½ | 7.78 | 3.88 | 2.60 | 1.94 | 1.56 | 1.30 | 1.12 | 0.98 | 0.86 | 0.78 |
| 2½ x 2½ x ⅛ | 2.13 | 1.07 | 0.71 | 0.53 | 0.43 | 0.36 | 0.30 | 0.27 | 0.24 | 0.21 |
| 2 x 2 x ½ | 4.80 | 2.40 | 1.60 | 1.20 | 0.96 | 0.80 | 0.69 | 0.60 | 0.53 | 0.48 |
| 2 x 2 x ⅛ | 1.60 | 0.80 | 0.54 | 0.40 | 0.32 | 0.26 | 0.22 | 0.20 | 0.18 | 0.16 |
| 1½ x 1½ x ⅜ | 2.06 | 1.04 | 0.68 | 0.52 | 0.42 | 0.34 | 0.30 | 0.26 | 0.22 | 0.20 |
| 1½ x 1½ x ⅛ | 0.82 | 0.42 | 0.28 | 0.20 | 0.16 | 0.14 | 0.12 | 0.10 | 0.10 | 0.08 |
| 1 x 1 x ¼ | 0.60 | 0.30 | 0.20 | 0.15 | 0.12 | 0.10 | 0.086 | 0.075 | 0.067 | 0.06 |
| 1 x 1 x ⅛ | 0.34 | 0.17 | 0.114 | 0.084 | 0.068 | 0.056 | 0.048 | 0.042 | 0.038 | 0.034 |

For safe loads to the right of heavy line the deflection will be greater than allowable for plastered ceiling.

# Angles with Unequal Legs

## Long Leg Vertical

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Angle**
**Neutral Axis Through Center of Gravity Parallel to Short Leg**

| Size of Angle, Inches | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8 x 6 x 1⅛ | 179.32 | 89.66 | 59.77 | 44.83 | 35.86 | 29.89 | 25.62 | 22.42 | 19.92 | 17.93 |
| 8 x 6 x ½ | 85.55 | 42.77 | 28.52 | 21.39 | 17.11 | 14.26 | 12.22 | 10.69 | 9.50 | 8.56 |
| 7 x 3½ x ⅞ | 100.48 | 50.24 | 33.49 | 25.12 | 20.10 | 16.75 | 14.35 | 12.56 | 11.16 | 10.05 |
| 7 x 3½ x 7/16 | 53.44 | 26.72 | 17.81 | 13.36 | 10.68 | 8.91 | 7.63 | 6.68 | 5.94 | 5.34 |
| 6 x 4 x 13/16 | 71.52 | 35.76 | 23.84 | 17.88 | 14.30 | 11.92 | 10.22 | 8.94 | 7.95 | 7.15 |
| 6 x 4 x ⅜ | 35.42 | 17.70 | 11.82 | 8.86 | 7.10 | 5.90 | 5.06 | 4.42 | 3.92 | 3.54 |
| 6 x 3½ x ¾ | 65.17 | 32.59 | 21.72 | 16.29 | 13.03 | 10.86 | 9.31 | 8.15 | 7.24 | 6.52 |
| 6 x 3½ x ⅜ | 34.66 | 17.34 | 11.54 | 8.66 | 6.94 | 5.78 | 4.96 | 4.34 | 3.84 | 3.46 |
| 5 x 4 x 13/16 | 49.93 | 24.96 | 16.64 | 12.48 | 9.99 | 8.32 | 7.13 | 6.24 | 5.54 | 4.99 |
| 5 x 4 x ⅜ | 25.06 | 12.53 | 8.35 | 6.26 | 5.01 | 4.18 | 3.58 | 3.13 | 2.78 | 2.51 |
| 5 x 3½ x ¾ | 45.69 | 22.84 | 15.23 | 11.42 | 9.14 | 7.61 | 6.53 | 5.71 | 5.08 | 4.57 |
| 5 x 3½ x 5/16 | 20.69 | 10.35 | 6.89 | 5.17 | 4.14 | 3.45 | 2.96 | 2.59 | 2.30 | 2.07 |
| 5 x 3 x 11/16 | 41.19 | 20.60 | 13.73 | 10.30 | 8.24 | 6.87 | 5.88 | 5,15 | 4.58 | 4.12 |
| 5 x 3 x 5/16 | 20.16 | 10.08 | 6.72 | 5.04 | 4.03 | 3.36 | 2.88 | 2.52 | 2.24 | 2.02 |
| 4½ x 3 x 11/16 | 33.47 | 16.74 | 11.16 | 8.37 | 6.69 | 5.58 | 4.78 | 4.18 | 3.72 | 3.35 |
| 4½ x 3 x 5/16 | 16.42 | 8.22 | 5.48 | 4.10 | 3.28 | 2.74 | 2.34 | 2.06 | 1.82 | 1.64 |
| 4 x 3½ x 13/16 | 29.12 | 14.56 | 9.70 | 7.28 | 5.82 | 4.86 | 4.16 | 3.66 | 3.22 | 2.90 |
| 4 x 3½ x 5/16 | 13.44 | 6.72 | 4.48 | 3.36 | 2.69 | 2.24 | 1.92 | 1.68 | 1.49 | 1.34 |
| 4 x 3 x 11/16 | 26.52 | 13.26 | 8.84 | 6.63 | 5.30 | 4.42 | 3.79 | 3.32 | 2.95 | 2.65 |
| 4 x 3 x ¼ | 10.67 | 5.33 | 3.56 | 2.67 | 2.14 | 1.78 | 1.52 | 1.33 | 1.19 | 1.07 |
| 3½ x 3 x 11/16 | 20.37 | 10.19 | 6.79 | 5.09 | 4.07 | 3.40 | 2.91 | 2.55 | 2.26 | 2.04 |
| 3½ x 3 x ¼ | 8.32 | 4.16 | 2.77 | 2.08 | 1.66 | 1.39 | 1.19 | 1.04 | 0.92 | 0.83 |
| 3½ x 2½ x 9/16 | 16.68 | 8.34 | 5.56 | 4.17 | 3.34 | 2.78 | 2.38 | 2.09 | 1.85 | 1.67 |
| 3½ x 2½ x ¼ | 8.00 | 4.00 | 2.67 | 2.00 | 1.60 | 1.33 | 1.14 | 1.00 | 0.89 | 0.80 |
| 3 x 2½ x 9/16 | 12.28 | 6.14 | 4.09 | 3.07 | 2.46 | 2.05 | 1.75 | 1.54 | 1.36 | 1.23 |
| 3 x 2½ x ¼ | 5.98 | 2.98 | 2.00 | 1.50 | 1.20 | 1.00 | 0.86 | 0.76 | 0.66 | 0.58 |
| 3 x 2 x ½ | 10.66 | 5.32 | 3.54 | 2.66 | 2.14 | 1.78 | 1.52 | 1.34 | 1.18 | 1.06 |
| 3 x 2 x 3/16 | 3.50 | 1.74 | 1.16 | 0.88 | 0.70 | 0.58 | 0.50 | 0.44 | 0.38 | 0.34 |
| 2½ x 2 x ½ | 7.58 | 3.78 | 2.52 | 1.90 | 1.52 | 1.26 | 1.08 | 0.94 | 0.84 | 0.76 |
| 2½ x 2 x 3/16 | 3.10 | 1.54 | 1.04 | 0.78 | 0.62 | 0.50 | 0.44 | 0.38 | 0.34 | 0.32 |

*For safe loads to the right of heavy line the deflection will be greater than allowable for plastered ceilings.*

# Angles With Unequal Legs

## Short Leg Vertical

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**

**Safe Loads Include Weight of Angle**

**Neutral Axis Through Center of Gravity Parallel to Long Leg**

| Size of Angle, Inches | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8 x 6 x 1⅛ | 105.61 | 52.80 | 35.20 | 26.40 | 21.12 | 17.60 | 15.09 | 13.20 | 11.73 | 10.56 |
| 8 x 6 x ½ | 51.09 | 25.55 | 17.03 | 12.77 | 10.22 | 8.51 | 7.30 | 6.38 | 5.68 | 5.11 |
| 7 x 3½ x ⅞ | 28.16 | 14.08 | 9.39 | 7.04 | 5.63 | 4.69 | 4.02 | 3.52 | 3.13 | 2.82 |
| 7 x 3½ x 7/16 | 15.36 | 7.68 | 5.12 | 3.84 | 3.07 | 2.56 | 2.19 | 1.92 | 1.71 | 1.54 |
| 6 x 4 x 13/16 | 33.95 | 16.97 | 11.32 | 8.49 | 6.79 | 5.66 | 4.85 | 4.24 | 3.77 | 3.39 |
| 6 x 4 x ⅜ | 17.06 | 8.54 | 5.68 | 4.26 | 3.42 | 2.86 | 2.44 | 2.14 | 1.90 | 1.70 |
| 6 x 3½ x ¾ | 24.24 | 12.12 | 8.08 | 6.06 | 4.85 | 4.04 | 3.46 | 3.03 | 2.69 | 2.42 |
| 6 x 3½ x ⅜ | 13.12 | 6.56 | 4.38 | 3.28 | 2.62 | 2.18 | 1.88 | 1.64 | 1.46 | 1.32 |
| 5 x 4 x 13/16 | 33.06 | 16.53 | 11.02 | 8.26 | 6.61 | 5.51 | 4.72 | 4.13 | 3.67 | 3.31 |
| 5 x 4 x ⅜ | 16.74 | 8.38 | 5.58 | 4.18 | 3.36 | 2.80 | 2.40 | 2.10 | 1.86 | 1.68 |
| 5 x 3½ x ¾ | 23.68 | 11.84 | 7.89 | 5.92 | 4.74 | 3.95 | 3.38 | 2.96 | 2.63 | 2.37 |
| 5 x 3½ x 5/16 | 10.88 | 5.44 | 3.63 | 2.72 | 2.18 | 1.81 | 1.55 | 1.36 | 1.21 | 1.09 |
| 5 x 3 x 11/16 | 16.10 | 8.05 | 5.37 | 4.02 | 3.22 | 2.68 | 2.30 | 2.01 | 1.79 | 1.61 |
| 5 x 3 x 5/16 | 8.00 | 4.00 | 2.67 | 2.00 | 1.60 | 1.33 | 1.14 | 1.00 | 0.89 | 0.80 |
| 4½ x 3 x 11/16 | 15.83 | 7.91 | 5.28 | 3.96 | 3.17 | 2.64 | 2.26 | 1.98 | 1.76 | 1.58 |
| 4½ x 3 x 5/16 | 8.10 | 4.06 | 2.70 | 2.02 | 1.62 | 1.36 | 1.16 | 1.02 | 0.90 | 0.82 |
| 4 x 3½ x 13/16 | 22.72 | 11.36 | 7.58 | 5.68 | 4.54 | 3.78 | 3.24 | 2.82 | 2.54 | 2.28 |
| 4 x 3½ x 5/16 | 10.67 | 5.33 | 3.56 | 2.67 | 2.13 | 1.78 | 1.52 | 1.33 | 1.12 | 1.06 |
| 4 x 3 x 11/16 | 15.57 | 7.79 | 5.19 | 3.89 | 3.11 | 2.58 | 2.22 | 1.95 | 1.73 | 1.56 |
| 4 x 3 x ¼ | 6.40 | 3.20 | 2.13 | 1.60 | 1.28 | 1.07 | 0.91 | 0.80 | 0.71 | 0.64 |
| 3½ x 3 x 11/16 | 15.36 | 7.68 | 5.12 | 3.84 | 3.07 | 2.56 | 2.19 | 1.92 | 1.70 | 1.53 |
| 3½ x 3 x ¼ | 6.19 | 3.10 | 2.06 | 1.54 | 1.24 | 1.03 | 0.88 | 0.77 | 0.69 | 0.62 |
| 3½ x 2½ x 9/16 | 8.98 | 4.49 | 2.99 | 2.25 | 1.80 | 1.50 | 1.28 | 1.12 | 1.00 | 0.90 |
| 3½ x 2½ x ¼ | 4.38 | 2.18 | 1.46 | 1.10 | 0.88 | 0.72 | 0.62 | 0.56 | 0.48 | 0.44 |
| 3 x 2½ x 9/16 | 8.76 | 4.38 | 2.92 | 2.19 | 1.75 | 1.46 | 1.25 | 1.09 | 0.97 | 0.88 |
| 3 x 2½ x ¼ | 4.26 | 2.14 | 1.42 | 1.06 | 0.86 | 0.72 | 0.64 | 0.54 | 0.48 | 0.42 |
| 3 x 2 x ½ | 5.02 | 2.50 | 1.68 | 1.26 | 1.00 | 0.84 | 0.72 | 0.64 | 0.56 | 0.50 |
| 3 x 2 x 3/16 | 2.14 | 1.06 | 0.72 | 0.54 | 0.42 | 0.36 | 0.30 | 0.26 | 0.24 | 0.22 |
| 2½ x 2 x ½ | 4.98 | 2.50 | 1.66 | 1.24 | 1.00 | 0.82 | 0.72 | 0.62 | 0.56 | 0.50 |
| 2½ x 2 x 3/16 | 2.02 | 1.02 | 0.66 | 0.50 | 0.40 | 0.34 | 0.30 | 0.26 | 0.22 | 0.20 |

For safe loads to the right of heavy line the deflection will be greater than allowable for plastered ceilings.

# Tees With Equal Legs

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**

**Safe Loads Include Weight of Tee**

| Section Index | Size Flange by Stem, Inches | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| T- 3 | 4 x 4 | 23.34 | 11.66 | 7.78 | 5.84 | 4.66 | 3.90 | 3.34 | 2.90 | 2.58 | 2.34 |
| T- 4 | 4 x 4 | 20.56 | 10.30 | 6.86 | 5.14 | 4.10 | 3.44 | 2.94 | 2.56 | 2.30 | 2.06 |
| T- 9 | 3½ x 3½ | 14.74 | 7.38 | 4.90 | 3.68 | 2.96 | 2.46 | 2.10 | 1.84 | 1.62 | 1.48 |
| T-10 | 3½ x 3½ | 12.78 | 6.38 | 4.26 | 3.20 | 2.56 | 2.14 | 1.84 | 1.60 | 1.42 | 1.28 |
| T-15 | 3 x 3 | 9.54 | 4.78 | 3.18 | 2.40 | 1.92 | 1.60 | 1.36 | 1.20 | 1.06 | 0.96 |
| T-16 | 3 x 3 | 8.22 | 4.10 | 2.74 | 2.06 | 1.66 | 1.36 | 1.18 | 1.02 | 0.90 | 0.82 |
| T-17 | 3 x 3 | 6.60 | 3.30 | 2.20 | 1.64 | 1.32 | 1.10 | 0.94 | 0.82 | 0.74 | 0.66 |
| T-22 | 2½ x 2½ | 6.50 | 3.26 | 2.16 | 1.62 | 1.30 | 1.10 | 0.94 | 0.80 | 0.72 | 0.64 |
| T-23 | 2½ x 2½ | 5.58 | 2.78 | 1.86 | 1.38 | 1.12 | 0.94 | 0.80 | 0.70 | 0.62 | 0.56 |
| T-28 | 2¼ x 2¼ | 4.26 | 2.14 | 1.42 | 1.06 | 0.86 | 0.72 | 0.62 | 0.54 | 0.48 | 0.42 |
| T-29 | 2¼ x 2¼ | 3.50 | 1.74 | 1.18 | 0.88 | 0.70 | 0.58 | 0.50 | 0.42 | 0.40 | 0.34 |
| T-33 | 2 x 2 | 3.16 | 1.58 | 1.05 | 0.79 | 0.63 | 0.52 | 0.45 | 0.40 | 0.35 | 0.32 |
| T-34 | 2 x 2 | 2.72 | 1.36 | 0.90 | 0.68 | 0.54 | 0.46 | 0.40 | 0.34 | 0.30 | 0.28 |
| T-39 | 1¾ x 1¾ | 2.06 | 1.02 | 0.70 | 0.52 | 0.40 | 0.34 | 0.30 | 0.26 | 0.24 | 0.20 |
| T-40 | 1¾ x 1¾ | 1.36 | 0.68 | 0.46 | 0.34 | 0.26 | 0.24 | 0.18 | 0.16 | 0.16 | 0.14 |
| T-45 | 1½ x 1½ | 1.46 | 0.74 | 0.48 | 0.38 | 0.30 | 0.24 | 0.22 | 0.18 | 0.16 | 0.14 |
| T-46 | 1½ x 1½ | 1.22 | 0.62 | 0.40 | 0.30 | 0.24 | 0.22 | 0.18 | 0.16 | 0.14 | 0.12 |
| T-51 | 1¼ x 1¼ | 1.04 | 0.52 | 0.34 | 0.26 | 0.22 | 0.18 | 0.16 | 0.14 | 0.12 | 0.10 |
| T-52 | 1¼ x 1¼ | 0.78 | 0.40 | 0.26 | 0.20 | 0.16 | 0.14 | 0.10 | 0.10 | 0.08 | 0.08 |
| T-57 | 1 x 1 | 0.50 | 0.26 | 0.16 | 0.14 | 0.10 | 0.08 | 0.08 | 0.06 | 0.06 | 0.06 |
| T-58 | 1 x 1 | 0.38 | 0.18 | 0.12 | 0.10 | 0.08 | 0.06 | 0.06 | 0.06 | 0.04 | 0.04 |

For safe loads to the right of heavy line the deflection will be greater than allowable for plastered ceilings.

# Tees With Unequal Legs

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**

**Safe Loads Include Weight of Tee**

| Section Index | Size Flange by Stem, Inches | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| *T-69 | 5 x 2½ | 9.18 | 4.58 | 3.06 | 2.30 | 1.84 | 1.52 | 1.32 | 1.14 | 1.02 | 0.92 |
| *T-74 | 4½ x 3 | 8.64 | 4.32 | 2.88 | 2.16 | 1.72 | 1.44 | 1.24 | 1.08 | 0.96 | 0.86 |
| T-79 | 4 x 2 | 4.27 | 2.14 | 1.42 | 1.07 | 0.86 | 0.71 | 0.61 | 0.53 | 0.47 | 0.43 |
| T-80 | 4 x 2 | 3.63 | 1.81 | 1.21 | 0.91 | 0.73 | 0.60 | 0.52 | 0.45 | 0.40 | 0.36 |
| T-85 | 3½ x 4 | 21.12 | 10.56 | 7.04 | 5.28 | 4.22 | 3.52 | 3.02 | 2.64 | 2.34 | 2.10 |
| T-86 | 3½ x 4 | 16.54 | 8.26 | 5.52 | 4.14 | 3.30 | 2.74 | 2.38 | 2.08 | 1.84 | 1.66 |
| T-91 | 3½ x 3 | 10.90 | 5.44 | 3.62 | 2.72 | 2.18 | 1.82 | 1.54 | 1.36 | 1.20 | 1.10 |
| T-92 | 3½ x 3 | 9.44 | 4.72 | 3.14 | 2.36 | 1.90 | 1.58 | 1.36 | 1.18 | 1.04 | 0.94 |
| T-96 | 3 x 3½ | 15.89 | 7.95 | 5.30 | 3.97 | 3.18 | 2.65 | 2.29 | 1.98 | 1.76 | 1.59 |
| T-97 | 3 x 3½ | 14.38 | 7.18 | 4.80 | 3.60 | 2.88 | 2.40 | 2.06 | 1.78 | 1.60 | 1.44 |
| T-98 | 3 x 3½ | 12.46 | 6.22 | 4.16 | 3.12 | 2.48 | 2.08 | 1.78 | 1.56 | 1.38 | 1.26 |
| T-103 | 2½ x 2 | 3.38 | 1.70 | 1.12 | 0.84 | 0.66 | 0.56 | 0.48 | 0.42 | 0.38 | 0.34 |
| T-108 | 2½ x 1¾ | 2.06 | 1.04 | 0.70 | 0.52 | 0.40 | 0.34 | 0.30 | 0.26 | 0.24 | 0.20 |
| T-112 | 2⅓ x 2¼ | 3.00 | 1.50 | 1.00 | 0.75 | 0.60 | 0.50 | 0.43 | 0.38 | 0.33 | 0.30 |

For safe loads to the right of heavy line the deflection will be greater than allowable for plastered ceilings.

*Made only by special arrangement.

# Zees

## Allowable Uniform Loads in Thousands of Pounds

### Extreme Fiber Stress, 16,000 Pounds per Square Inch

### Safe Loads Include Weight of Zee

| Section Index | Size Depth, Inches | Size Flange, Inches | Weight per Foot, Pounds | Span in Feet | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 |
| Z-70 | 5 1/8 | 3 3/8 | 28.4 | 29.81 | 23.89 | 19.91 | 17.07 | 14.93 | 13.27 | 11.95 | 9.96 | 8.53 | 7.47 |
| Z-71 | 5 1/16 | 3 5/16 | 26.0 | 27.57 | 22.06 | 18.38 | 15.76 | 13.78 | 12.25 | 11.03 | 9.19 | 7.87 | 6.89 |
| Z-72 | 5 | 3 1/4 | 23.7 | 25.25 | 20.20 | 16.83 | 14.43 | 12.62 | 11.22 | 10.10 | 8.41 | 7.21 | 6.31 |
| Z-73 | 5 1/8 | 3 3/8 | 22.6 | 25.52 | 20.41 | 17.01 | 14.58 | 12.76 | 11.34 | 10.21 | 8.50 | 7.29 | 6.38 |
| Z-74 | 5 1/16 | 3 5/16 | 20.2 | 22.99 | 18.39 | 15.32 | 13.13 | 11.49 | 10.21 | 9.20 | 7.66 | 6.56 | 5.74 |
| Z-75 | 5 | 3 1/4 | 17.9 | 20.48 | 16.38 | 13.65 | 11.70 | 10.24 | 9.10 | 8.19 | 6.83 | 5.85 | 5.12 |
| Z-76 | 5 1/8 | 3 3/8 | 16.4 | 19.84 | 15.87 | 13.22 | 11.33 | 9.92 | 8.82 | 7.93 | 6.61 | 5.66 | 4.96 |
| Z-77 | 5 1/16 | 3 5/16 | 14.0 | 17.04 | 13.63 | 11.36 | 9.73 | 8.52 | 7.57 | 6.81 | 5.68 | 4.86 | 4.26 |
| Z-78 | 5 | 3 1/4 | 11.6 | 14.24 | 11.39 | 9.49 | 8.13 | 7.12 | 6.33 | 5.69 | 4.74 | 4.06 | 3.56 |
| Z-80 | 4 1/8 | 3 3/16 | 23.0 | 19.36 | 15.49 | 12.90 | 11.06 | 9.68 | 8.60 | 7.74 | 6.45 | 5.53 | 4.84 |
| Z-81 | 4 1/16 | 3 1/8 | 20.9 | 17.73 | 14.18 | 11.82 | 10.13 | 8.86 | 7.88 | 7.09 | 5.91 | 5.06 | 4.43 |
| Z-82 | 4 | 3 1/16 | 18.9 | 16.13 | 12.90 | 10.74 | 9.22 | 8.06 | 7.17 | 6.45 | 5.37 | 4.61 | 4.03 |
| Z-83 | 4 1/8 | 3 3/16 | 18.0 | 16.48 | 13.18 | 10.98 | 9.41 | 8.24 | 7.32 | 6.59 | 5.49 | 4.70 | 4.12 |
| Z-84 | 4 1/16 | 3 1/8 | 15.9 | 14.66 | 11.73 | 9.78 | 8.38 | 7.33 | 6.52 | 5.86 | 4.89 | 4.19 | 3.66 |
| Z-85 | 4 | 3 1/16 | 13.8 | 12.88 | 10.30 | 8.58 | 7.36 | 6.44 | 5.72 | 5.15 | 4.29 | 3.68 | 3.22 |
| Z-86 | 4 1/8 | 3 3/16 | 12.5 | 12.45 | 9.96 | 8.30 | 7.11 | 6.22 | 5.53 | 4.98 | 4.15 | 3.55 | 3.11 |
| Z-87 | 4 1/16 | 3 1/8 | 10.3 | 10.43 | 8.34 | 6.94 | 5.96 | 5.21 | 4.63 | 4.17 | 3.47 | 2.98 | 2.60 |
| Z-88 | 4 | 3 1/16 | 8.2 | 8.37 | 6.70 | 5.58 | 4.78 | 4.18 | 3.72 | 3.35 | 2.79 | 2.39 | 2.09 |
| Z-3 | 3 1/16 | 2 3/4 | 14.3 | 9.15 | 7.32 | 6.09 | 5.22 | 4.57 | 4.06 | 3.66 | 3.05 | 2.61 | 2.28 |
| Z-4 | 3 | 2 11/16 | 12.6 | 8.16 | 6.53 | 5.44 | 4.66 | 4.08 | 3.62 | 3.26 | 2.72 | 2.33 | 2.04 |
| Z-7 | 3 1/16 | 2 3/4 | 11.5 | 7.95 | 6.36 | 5.29 | 4.54 | 3.97 | 3.53 | 3.18 | 2.65 | 2.27 | 1.98 |
| Z-8 | 3 | 2 11/16 | 9.8 | 6.85 | 5.48 | 4.57 | 3.91 | 3.42 | 3.04 | 2.74 | 2.28 | 1.95 | 1.71 |
| Z-11 | 3 1/16 | 2 3/4 | 8.5 | 6.35 | 5.08 | 4.23 | 3.63 | 3.17 | 2.82 | 2.54 | 2.11 | 1.81 | 1.58 |
| Z-12 | 3 | 2 11/16 | 6.7 | 5.12 | 4.09 | 3.41 | 2.92 | 2.56 | 2.27 | 2.05 | 1.70 | 1.46 | 1.28 |
| Z-18 | 3 | 1 1/2 | 3.59 | 2.72 | 2.18 | 1.81 | 1.55 | 1.36 | 1.21 | 1.09 | 0.91 | 0.78 | 0.68 |

# Zees

Continued

## Allowable Uniform Loads in Thousands of Pounds

**Extreme Fiber Stress, 16,000 Pounds per Square Inch**
**Safe Loads Include Weight of Zee**
**Neutral Axis Parallel to Flanges**

| Size | | | Weight per Foot, Pounds | 1 Foot Span | Maximum Span 360 x Deflection | |
|---|---|---|---|---|---|---|
| Depth, Inches | Flanges, Inches | Thickness, Inches | | Safe Load | Safe Load | Length, Feet |
| 5 1/8 | 3 3/8 | 13/16 | 28.4 | 119.47 | 1.16 | 10.3 |
| 5 1/16 | 3 5/16 | 3/4 | 26.0 | 110.29 | 1.08 | 10.2 |
| 5 | 3 1/4 | 11/16 | 23.7 | 101.01 | 1.00 | 10.1 |
| 5 1/8 | 3 3/8 | 5/8 | 22.6 | 102.08 | 0.99 | 10.3 |
| 5 1/16 | 3 5/16 | 9/16 | 20.2 | 91.95 | 0.90 | 10.2 |
| 5 | 3 1/4 | 1/2 | 17.9 | 81.92 | 0.81 | 10.1 |
| 5 1/8 | 3 3/8 | 7/16 | 16.4 | 79.36 | 0.77 | 10.3 |
| 5 1/16 | 3 5/16 | 3/8 | 14.0 | 68.16 | 0.67 | 10.2 |
| 5 | 3 1/4 | 5/16 | 11.6 | 56.96 | 0.57 | 10.1 |
| 4 1/8 | 3 3/16 | 3/4 | 23.0 | 77.44 | 0.93 | 8.3 |
| 4 1/16 | 3 1/8 | 11/16 | 20.9 | 70.93 | 0.87 | 8.2 |
| 4 | 3 1/16 | 5/8 | 18.9 | 64.53 | 0.80 | 8.1 |
| 4 1/8 | 3 3/16 | 9/16 | 18.0 | 65.92 | 0.79 | 8.3 |
| 4 1/16 | 3 1/8 | 1/2 | 15.9 | 58.67 | 0.72 | 8.2 |
| 4 | 3 1/16 | 7/16 | 13.8 | 51.52 | 0.64 | 8.1 |
| 4 1/8 | 3 3/16 | 3/8 | 12.5 | 49.81 | 0.60 | 8.3 |
| 4 1/16 | 3 1/8 | 5/16 | 10.3 | 41.71 | 0.51 | 8.2 |
| 4 | 3 1/16 | 1/4 | 8.2 | 33.49 | 0.41 | 8.1 |
| 3 1/16 | 2 3/4 | 9/16 | 14.3 | 36.59 | 0.59 | 6.2 |
| 3 | 2 11/16 | 1/2 | 12.6 | 32.64 | 0.54 | 6.1 |
| 3 1/16 | 2 3/4 | 7/16 | 11.5 | 31.79 | 0.51 | 6.2 |
| 3 | 2 11/16 | 3/8 | 9.8 | 27.41 | 0.45 | 6.1 |
| 3 1/16 | 2 3/4 | 5/16 | 8.5 | 25.39 | 0.41 | 6.2 |
| 3 | 2 11/16 | 1/4 | 6.7 | 20.48 | 0.34 | 6.1 |
| 3 | 1 1/2 | 3/16 | 3.59 | 10.89 | 0.18 | 2.7 |
| 2 | 1 1/2 | 1/4 | 3.80 | 11.60 | 0.20 | 3.0 |
| 1 5/8 | 1 1/2 | 3/8x5/16 | 4.2 | 12.73 | 0.21 | 3.2 |

# Beam Box Girders

## Allowable Uniform Loads in Thousands of Pounds

The values below are based on extreme fiber stress of 16,000 pounds per square inch, $\frac{13}{16}''$ rivet holes deducted. Weights correspond to length, center to center of bearings.

2-10" Beams
25 Pounds per Foot


2-12" x ½"
Steel Plates

| Distance, Center to Center of Bearings, Feet | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Add to Safe Load for 5 Pounds Increase in Weight of Beam | Add to Safe Load for $\frac{1}{16}''$ Increase in Thickness of Plates | Add to Weight of Girder for 5 Pounds Increase in Weight of Beam | Add to Weight of Girder for $\frac{1}{16}''$ Increase in Thickness of Plates |
|---|---|---|---|---|---|---|
| 12 | 80.0 | 1,114 | 3.84 | 5.78 | 120 | 61 |
| 13 | 73.8 | 1,206 | 3.54 | 5.34 | 130 | 66 |
| 14 | 68.6 | 1,299 | 3.28 | 4.96 | 140 | 71 |
| 15 | 64.0 | 1,392 | 3.08 | 2.62 | 150 | 77 |
| 16 | 60.0 | 1,485 | 2.88 | 2.32 | 160 | 82 |
| 17 | 56.4 | 1,578 | 2.70 | 2.08 | 170 | 87 |
| 18 | 53.4 | 1,670 | 2.56 | 3.86 | 180 | 92 |
| 19 | 50.6 | 1,763 | 2.40 | 3.64 | 190 | 97 |
| 20 | 48.0 | 1,856 | 2.28 | 3.46 | 200 | 102 |
| 21 | 45.6 | 1,949 | 2.18 | 3.28 | 210 | 107 |
| 22 | 43.4 | 2,042 | 2.08 | 3.14 | 220 | 112 |
| 23 | 41.8 | 2,134 | 2.00 | 3.02 | 230 | 117 |
| 24 | 40.0 | 2,227 | 1.92 | 2.88 | 240 | 122 |
| 25 | 38.4 | 2,320 | 1.84 | 2.78 | 250 | 128 |
| 26 | 37.0 | 2,413 | 1.78 | 2.66 | 260 | 133 |
| 27 | 35.6 | 2,506 | 1.68 | 2.56 | 270 | 138 |
| 28 | 34.2 | 2,598 | 1.64 | 2.48 | 280 | 143 |
| 29 | 33.0 | 2,691 | 1.58 | 2.38 | 290 | 148 |
| 30 | 32.0 | 2,784 | 1.52 | 2.32 | 300 | 153 |
| 31 | 31.0 | 2,877 | 1.48 | 2.24 | 310 | 158 |
| 32 | 30.0 | 2,970 | 1.42 | 2.16 | 320 | 163 |
| 33 | 29.0 | 3,062 | 1.40 | 2.08 | 330 | 168 |
| 34 | 28.2 | 3,155 | 1.36 | 2.04 | 340 | 173 |
| 35 | 27.4 | 3,248 | 1.30 | 2.00 | 350 | 179 |
| 36 | 26.6 | 3,341 | 1.28 | 1.92 | 360 | 184 |
| 37 | 26.0 | 3,434 | 1.24 | 1.86 | 370 | 189 |
| 38 | 25.2 | 3,526 | 1.20 | 1.72 | 380 | 194 |

# Beam Box Girders

### Continued

## Allowable Uniform Loads in Thousands of Pounds

The values below are based on extreme fiber stress of 16,000 pounds per square inch, $\frac{13}{16}$" rivet holes deducted. Weights correspond to lengths, center to center of bearings.

| Distance, Center to Center of Bearings, Feet | 2-18" Beams 70 Pounds per Foot  2-16" x 3/4 Steel Plates | | | 2-18" Beams 55 Pounds per Foot  2-16" x 3/4" Steel Plates | | | Add to Safe Load for $\frac{1}{16}$" Increase in Thickness of Plates | Add to Weight of Girder for $\frac{1}{16}$" Increase in Thickness of Plates |
|---|---|---|---|---|---|---|---|---|
| | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Add to Safe Load for $\frac{1}{16}$" Increase in Thickness of Plates | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Add to Safe Load for 5 Pounds Increase in Weight of Beam | | |
| 12 | 325.2 | 2,712 | 13.36 | 302.6 | 2,352 | 7.84 | 13.36 | 82 |
| 13 | 300.2 | 2,938 | 12.34 | 279.4 | 2,548 | 7.24 | 12.34 | 88 |
| 14 | 278.8 | 3,164 | 11.46 | 259.4 | 2,744 | 6.72 | 11.46 | 95 |
| 15 | 260.2 | 3,390 | 10.70 | 242.2 | 2,940 | 6.28 | 10.70 | 102 |
| 16 | 243.8 | 3,616 | 10.02 | 227.0 | 3,136 | 5.88 | 10.02 | 109 |
| 17 | 229.6 | 3,842 | 9.44 | 213.6 | 3,332 | 5.54 | 9.44 | 116 |
| 18 | 216.8 | 4,068 | 8.90 | 201.8 | 3,528 | 5.22 | 8.90 | 122 |
| 19 | 205.4 | 4,294 | 8.44 | 191.2 | 3,724 | 4.94 | 8.44 | 129 |
| 20 | 195.0 | 4,520 | 8.02 | 181.6 | 3,920 | 4.70 | 8.02 | 136 |
| 21 | 185.8 | 4,746 | 7.64 | 173.0 | 4,116 | 4.48 | 7.64 | 143 |
| 22 | 177.4 | 4,972 | 7.28 | 163.4 | 4,312 | 4.28 | 7.28 | 150 |
| 23 | 169.6 | 5,198 | 6.98 | 157.8 | 4,508 | 4.08 | 6.98 | 156 |
| 24 | 162.6 | 5,424 | 6.68 | 151.4 | 4,704 | 3.92 | 6.68 | 163 |
| 25 | 156.0 | 5,650 | 6.42 | 145.2 | 4,900 | 3.76 | 6.42 | 170 |
| 26 | 150.0 | 5,876 | 6.16 | 139.6 | 5,096 | 3.62 | 6.16 | 177 |
| 27 | 144.4 | 6,102 | 5.94 | 134.4 | 5,292 | 3.48 | 5.94 | 184 |
| 28 | 139.4 | 6,328 | 5.72 | 129.6 | 5,488 | 3.36 | 5.72 | 190 |
| 29 | 134.6 | 6,554 | 5.52 | 125.2 | 5,684 | 3.24 | 5.52 | 197 |
| 30 | 130.0 | 6,780 | 5.34 | 121.0 | 5,880 | 3.14 | 5.34 | 204 |
| 31 | 125.8 | 7,006 | 5.16 | 117.2 | 6,076 | 3.04 | 5.16 | 211 |
| 32 | 122.0 | 7,232 | 5.00 | 113.4 | 6,272 | 2.94 | 5.00 | 218 |
| 33 | 118.2 | 7,458 | 4.86 | 109.0 | 6,468 | 2.84 | 4.86 | 224 |
| 34 | 114.8 | 7,684 | 4.72 | 106.8 | 6,664 | 2.76 | 4.72 | 231 |
| *35* | *111.4* | *7,910* | 4.58 | 103.8 | 6,860 | 2.68 | 4.58 | 238 |
| *36* | *108.4* | *8,136* | 4.46 | 100.8 | 7,056 | 2.60 | 4.46 | 245 |
| *37* | *105.4* | *8,362* | 4.34 | 98.2 | 7,252 | 2.52 | 4.34 | 252 |
| *38* | *102.6* | *8,588* | 4.22 | 95.6 | 7,448 | 2.46 | 4.22 | 258 |

# Beam Box Girders

### Continued

## Allowable Uniform Loads in Thousands of Pounds

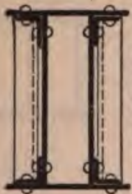
The values below are based on extreme fiber stress of 16,000 pounds per square inch, 13/16" rivet holes deducted. Weights correspond to lengths, center to center of bearings.

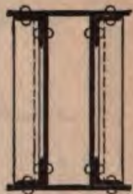
| Distance, Center to Center of Bearings, Feet | 2-20" Steel Beams 65 Pounds per Foot  2-16" x 3/4" Steel Plates | | | | 2-24" Steel Beams 80 Pounds per Foot  2-16" x 3/4" Steel Plates | | | | Add to Weight of Girder for 1/16" Increase in Thickness of Plates |
|---|---|---|---|---|---|---|---|---|---|
| | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Add to Safe Load for 5 Pounds Increase in Weight of Beam | Add to Safe Load for 1/16" Increase in Thickness of Plates | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Add to Safe Load for 5 Pounds Increase in Weight of Beam | Add to Safe Load for 1/16" Increase in Thickness of Plates | |
| 12 | 366.0 | 2,563 | 8.72 | 16.00 | 513.2 | 2,923 | 10.46 | 19.16 | 82 |
| 13 | 337.6 | 2,777 | 8.04 | 14.76 | 473.6 | 3,167 | 9.66 | 17.68 | 88 |
| 14 | 313.6 | 2,990 | 7.48 | 13.70 | 439.8 | 3,410 | 8.96 | 16.42 | 95 |
| 15 | 292.8 | 3,204 | 6.96 | 12.80 | 410.4 | 3,654 | 8.36 | 15.32 | 102 |
| 16 | 274.4 | 3,418 | 6.52 | 12.00 | 384.8 | 3,898 | 7.84 | 14.36 | 109 |
| 17 | 258.4 | 3,631 | 6.04 | 11.28 | 362.2 | 4,141 | 7.40 | 13.52 | 116 |
| 18 | 244.0 | 3,845 | 5.80 | 10.66 | 342.0 | 4,385 | 6.98 | 12.78 | 122 |
| 19 | 231.0 | 4,058 | 5.52 | 10.10 | 324.2 | 4,628 | 6.60 | 12.10 | 129 |
| 20 | 219.6 | 4,272 | 5.24 | 9.60 | 307.8 | 4,872 | 6.28 | 11.50 | 136 |
| 21 | 209.0 | 4,486 | 5.00 | 9.12 | 293.2 | 5,116 | 5.98 | 10.94 | 143 |
| 22 | 199.6 | 4,699 | 4.76 | 8.72 | 279.8 | 5,359 | 5.70 | 10.44 | 150 |
| 23 | 190.8 | 4,913 | 4.56 | 8.34 | 267.8 | 5,603 | 5.46 | 10.00 | 156 |
| 24 | 183.0 | 5,126 | 4.36 | 8.00 | 256.6 | 5,846 | 5.22 | 9.58 | 163 |
| 25 | 175.6 | 5,340 | 4.16 | 7.68 | 246.2 | 6,090 | 5.02 | 9.20 | 170 |
| 26 | 168.8 | 5,554 | 4.00 | 7.38 | 236.8 | 6,334 | 4.82 | 8.84 | 177 |
| 27 | 162.6 | 5,767 | 3.84 | 7.10 | 228.0 | 6,577 | 4.64 | 8.50 | 184 |
| 28 | 156.8 | 5,981 | 3.72 | 6.86 | 219.8 | 6,821 | 4.48 | 8.20 | 190 |
| 29 | 151.4 | 6,194 | 3.60 | 6.62 | 212.2 | 7,064 | 4.32 | 7.92 | 197 |
| 30 | 146.4 | 6,408 | 3.48 | 6.40 | 205.2 | 7,308 | 4.18 | 7.66 | 204 |
| 31 | 141.6 | 6,622 | 3.36 | 6.18 | 198.6 | 7,552 | 4.04 | 7.42 | 211 |
| 32 | 137.2 | 6,835 | 3.24 | 6.00 | 192.4 | 7,795 | 3.92 | 7.18 | 218 |
| 33 | 133.0 | 7,049 | 3.16 | 5.82 | 186.6 | 8,039 | 3.80 | 6.96 | 224 |
| 34 | 129.2 | 7,262 | 3.04 | 5.64 | 181.0 | 8,282 | 3.70 | 6.76 | 231 |
| 35 | 125.4 | 7,476 | 2.92 | 5.48 | 176.0 | 8,526 | 3.58 | 6.56 | 238 |
| 36 | 122.0 | 7,690 | 2.80 | 5.32 | 171.0 | 8,770 | 3.48 | 6.38 | 245 |
| 37 | 118.6 | 7,903 | 2.76 | 5.18 | 166.4 | 9,013 | 3.40 | 6.20 | 252 |
| 38 | 115.4 | 8,117 | 2.72 | 5.04 | 162.0 | 9,257 | 3.30 | 6.04 | 258 |

# Plate Box Girders

## Allowable Uniform Loads in Thousands of Pounds

The values below are founded on the moments of inertia of the sections using an extreme fiber stress of 16,000 pounds per square inch for steel; $\frac{13}{16}$" rivet holes in both flanges deducted. Weight of girders correspond to lengths, center to center of bearings and include rivet heads, stiffeners and fillers.





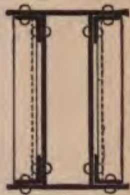
| Distance, Center to Center of Bearings, Feet | 30" x ½" Web Plates, 16" x ⅝" Flange Plates, 3½" x 3½" x ½" Angles | | | | 33" x ½" Web Plates, 20" x $\frac{1}{16}$" Flange Plates, 3½" x 3½" x ½" Angles | | | |
|---|---|---|---|---|---|---|---|---|
| | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Increase in Safe Load for $\frac{1}{16}$" Increase in Thickness of Flange Plates | Increase in Weight of Girder for $\frac{1}{16}$" Increase in Thickness of Flange Plates | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Increase in Safe Load for $\frac{1}{16}$" Increase in Thickness of Flange Plates | Increase in Weight of Girder for $\frac{1}{16}$" Increase in Thickness of Flange Plates |
| 20 | 240.00 | 4.26 | 14.08 | .07 | 320.4 | 4.88 | 19.08 | .09 |
| 21 | 228.56 | 4.46 | 13.40 | .07 | 315.2 | 5.10 | 18.16 | .09 |
| 22 | 218.18 | 4.64 | 12.80 | .08 | 291.2 | 5.32 | 17.34 | .09 |
| 23 | 208.68 | 4.90 | 12.24 | .08 | 278.6 | 5.60 | 16.58 | .10 |
| 24 | 200.00 | 5.08 | 11.72 | .08 | 267.0 | 5.82 | 15.90 | .10 |
| 25 | 192.00 | 5.28 | 11.26 | .09 | 256.4 | 6.06 | 15.26 | .11 |
| 26 | 184.60 | 5.48 | 10.82 | .09 | 246.4 | 6.28 | 14.68 | .11 |
| 27 | 177.76 | 5.66 | 10.42 | .09 | 237.4 | 6.50 | 14.14 | .12 |
| 28 | 171.42 | 5.86 | 10.06 | .10 | 228.8 | 6.72 | 13.64 | .12 |
| 29 | 165.52 | 6.12 | 9.70 | .10 | 221.0 | 7.00 | 13.16 | .12 |
| 30 | 160.00 | 6.32 | 9.38 | .10 | 213.6 | 7.22 | 12.72 | .13 |
| 31 | 154.84 | 6.50 | 9.08 | .11 | 206.6 | 7.44 | 12.30 | .13 |
| 32 | 150.00 | 6.70 | 8.80 | .11 | 200.2 | 7.66 | 11.92 | .14 |
| 33 | 145.44 | 7.00 | 8.52 | .11 | 194.2 | 7.90 | 11.56 | .14 |
| 34 | 141.18 | 7.08 | 8.28 | .12 | 188.4 | 8.12 | 11.20 | .14 |
| 35 | 137.14 | 7.28 | 8.04 | .12 | 183.0 | 8.34 | 10.88 | .15 |
| 36 | 133.32 | 7.52 | 7.82 | .12 | 178.0 | 8.62 | 10.58 | .15 |
| 37 | 129.72 | 7.72 | 7.60 | .13 | 173.2 | 8.82 | 10.28 | .16 |
| 38 | 126.32 | 7.90 | 7.40 | .13 | 168.6 | 9.06 | 10.02 | .16 |
| 39 | 122.08 | 8.10 | 7.22 | .13 | 164.2 | 9.30 | 9.76 | .17 |
| 40 | 120.00 | 8.30 | 7.04 | .14 | 160.2 | 9.52 | 9.54 | .17 |

# Plate Box Girders

### Continued

## Allowable Uniform Loads in Thousands of Pounds

The values below are founded on the moments of inertia of the sections using an extreme fiber stress of 16,000 pounds per square inch for steel; 13/16" rivet holes in both flanges deducted. Weights of girders correspond to lengths, center to center of bearings and include rivet heads, stiffeners and fillers.

| Distance, Center to Center of Bearings, Feet |  36" x ½" Web Plates, 24" x 9/16" Flange Plates, 4" x 3½" x ½" Angles | | | |  42" x ½" Web Plates, 30" x 11/16" Flange Plates, 5" x 4" x ½" Angles | | | |
|---|---|---|---|---|---|---|---|---|
| | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Increase in Safe Load for 1/16" Increase in Thickness of Flange Plates | Increase in Weight of Girder for 1/16" Increase in Thickness of Flange Plates | Safe Load, including Weight of Girder | Weight of Girder, Pounds | Increase in Safe Load for 1/16" Increase in Thickness of Flange Plates | Increase in Weight of Girder for 1/16" Increase in Thickness of Flange Plates |
| 20 | 455.0 | 5.84 | 25.84 | .10 | 710.0 | 7.56 | 38.46 | .13 |
| 21 | 433.4 | 6.12 | 24.60 | .11 | 676.2 | 7.90 | 37.00 | .13 |
| 22 | 413.8 | 6.38 | 23.48 | .11 | 645.6 | 8.26 | 35.32 | .14 |
| 23 | 395.8 | 6.72 | 22.46 | .12 | 617.4 | 8.68 | 33.78 | .15 |
| 24 | 379.2 | 6.98 | 21.52 | .12 | 592.0 | 9.04 | 32.38 | .15 |
| 25 | 364.0 | 7.26 | 20.66 | .13 | 568.0 | 9.38 | 31.08 | .16 |
| 26 | 350.0 | 7.52 | 19.88 | .13 | 546.2 | 9.74 | 29.88 | .17 |
| 27 | 337.0 | 7.78 | 19.14 | .14 | 526.0 | 10.08 | 28.78 | .17 |
| 28 | 325.2 | 8.06 | 18.44 | .14 | 507.2 | 10.42 | 27.76 | .18 |
| 29 | 313.8 | 8.30 | 17.82 | .15 | 489.6 | 10.86 | 26.80 | .19 |
| 30 | 303.4 | 8.66 | 17.22 | .15 | 473.4 | 11.22 | 25.90 | .19 |
| 31 | 293.6 | 8.90 | 16.66 | .16 | 458.0 | 11.56 | 25.06 | .20 |
| 32 | 284.4 | 9.20 | 16.14 | .16 | 443.8 | 11.90 | 24.28 | .20 |
| 33 | 275.8 | 9.48 | 15.66 | .17 | 430.4 | 12.24 | 23.54 | .21 |
| 34 | 267.6 | 9.74 | 15.20 | .17 | 417.6 | 12.58 | 22.86 | .22 |
| 35 | 260.0 | 10.00 | 14.76 | .18 | 405.8 | 12.94 | 22.20 | .22 |
| 36 | 252.8 | 10.34 | 14.34 | .18 | 394.4 | 13.38 | 21.58 | .23 |
| 37 | 246.0 | 10.62 | 13.96 | .19 | 383.8 | 13.72 | 21.00 | .24 |
| 38 | 239.4 | 10.88 | 13.60 | .19 | 373.6 | 13.88 | 20.44 | .24 |
| 39 | 233.4 | 11.16 | 13.24 | .20 | 364.2 | 14.40 | 19.92 | .25 |
| 40 | 227.6 | 11.42 | 12.92 | .20 | 355.0 | 14.76 | 19.42 | .26 |

## Columns and Struts

Members in a structure subject to compression are termed—Columns, Posts or Struts. Theory offers no exact formulae from which the strength of these members, under various conditions of loading may be figured. Empirical formulae, based on the assumption that the members under stress may fail by direct compression, by combined compression and bending, or bending alone, practically agree with results obtained by experiment on full sized members. These experiments show that steel columns of ordinary sizes and lengths fail at nearly a constant stress which corresponds to the yield point of that material, and that the load which will cause the column to fail decreases in the ratio of its length to its least radius of gyration.

### Strength of Columns

Columns are dependent upon their area and shape of cross section for their strength. Long columns will fail by bending under less load than will short columns. Of two columns having the same sectional area, the one having the material in the section distributed farthest from the central axis of the column will be stronger than the one having the bulk of material located near the center. If all the material composing the cross section of a column could be located at a distance from the center equal to the radius of gyration, the column would possess the same strength to resist flexure as though the material was distributed over the cross section. Therefore, in formulae for calculating the strength of columns, both the radius of gyration and the length must be taken into consideration.

### Design of Columns

Hollow round columns are the most economical in material, and single web columns are the most accessible for painting and inspection. Columns should be so designed as to facilitate connecting floor beams or girders on all sides. Connections to columns should be carefully designed and provided with sufficient rivets, to avoid failure of the connections by shearing of the rivets. It is the common practice to space rivets not more than 3 inches, center to center, at the ends of columns for a distance equal to twice the width of the column. The distance between rivets from center to center, in a direction parallel with the line of strain, should not exceed 16 times the least thickness of the thinnest outside plate; and the distance from center to center between the rivets at right angles to the line of strain, should not exceed 32 times the least thickness of metal.

### Tabulated Column Sections

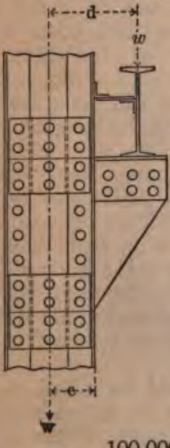
*On pages 182 to 203* will be found the safe loads in thousands of *pounds for column* sections, not exceeding lengths of 150 radii, *which are typical of* present day use.

## Columns
### Continued
### Formulae for Safe Loads

Columns subject to eccentric loading may be figured for safe carrying capacity by the following formulae:

$$A = \frac{W}{P} + \frac{w\,d\,e}{P\,r^2}$$

$P$ = Working unit stress (pounds square inch)
$A$ = Area of column (square inches)
$W$ = Total direct and eccentric loads (pounds)
$w$ = Eccentric load (pounds)
$d$ = Eccentricity of $w$ (inches)
$r$ = Radius of gyration in direction of eccentricity (inches)
$e$ = Distance from center of column to outer fiber in direction of eccentricity (inches)




EXAMPLE:

Required the sectional area of a 12″ plate and angle column 18′ 0″ long necessary to sustain safely a direct load of 100,000 pounds, and an eccentric load of 20,000 pounds located at a distance of 12″ from center of column in the direction of web.

From the column tables on page 188, we find the safe working unit stress for a 12″ column 18′ 0″ long to be about 10,000 pounds.

The trial radius of gyration may be taken as 5, which corresponds to the radius about the *y-y* axis for one of the 12″ columns.

The required area of the cross section of column may be computed as follows:

$$A = \frac{100{,}000 + 20{,}000}{10{,}000} + \frac{20{,}000 \times 12 \times 6\frac{1}{4}}{10{,}000 \times 25}$$
$$= 12^{\square''} + 6^{\square''}$$
$$= 18^{\square''}$$

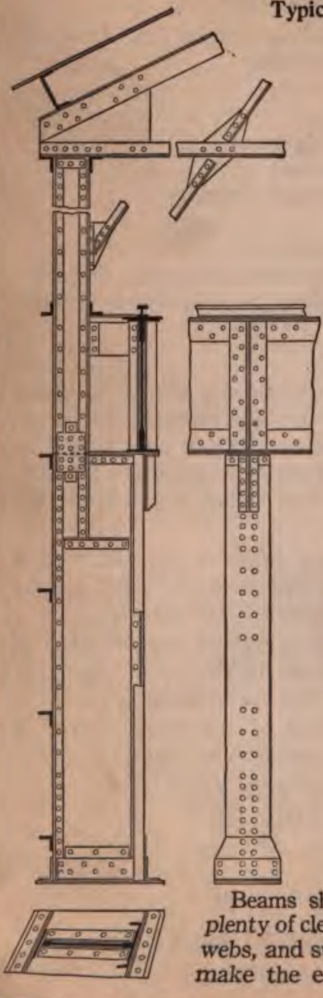
And the following column section may be used:

$\left.\begin{array}{l}\text{4 - 6″ × 4″ × 3/8″ angles}\\ \text{1 - 12″ × 3/8″ plate}\end{array}\right\}$ Area 18.94 square inches.

# Columns

**Continued**

## Typical Details



In designing and detailing mill and office buildings, it is desirable to have the loads transmitted from the trusses, girders and beams directly to the columns and eliminate bending or secondary stresses.

For the most economical construction, simplicity in details is very essential, and the number of connecting pieces, rivets or bolts should be reduced to a minimum.

The typical column details shown on these pages cover a few examples of the most modern practice in structural work, as met with in the ordinary mill and office building construction.

When columns rest on masonry, gusset plates may be required to distribute the load. Where they rest on steel slabs or cast iron bases, the loads are transmitted directly into the footing, and base angles only are required to fasten columns to slabs or bases.

Column should be milled to accurately bear at splices and base, to have splice plates of sufficient size with the necessary rivets to hold the section in line and to resist the stresses due to bending.

Beams should be framed to columns with plenty of clearance especially when framing into webs, and sufficient rivets countersunk so as to make the erection as simple as possible.

# Columns

### Continued

## Typical Built Sections

Fig. 1

Fig. 2

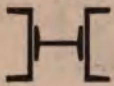


Fig. 3

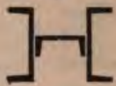


Fig. 4

Fig. 5

Fig. 6

Fig. 7

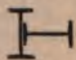
Fig. 8

Fig. 9

Fig. 10

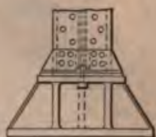
Fig. 11

Fig. 12



Column Base
for light loads
Fig. 13

Built up Column Base
for heavy loads
Fig. 14



Column Base with
Cast Iron or
Cast Steel Base
Fig. 15

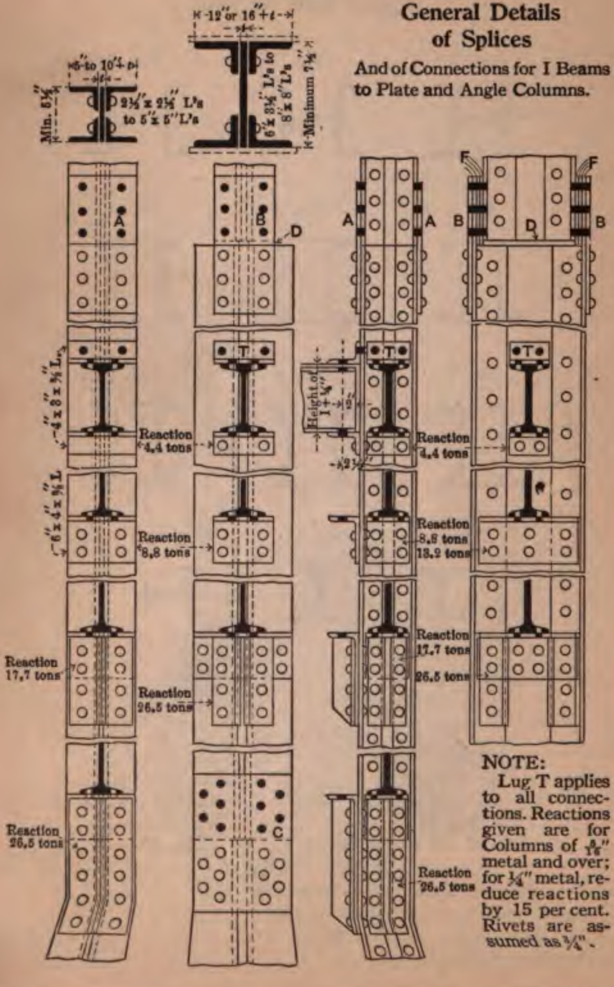
*Dotted lines indicate lattice*

# Columns

**Continued**

## General Details of Splices

And of Connections for I Beams to Plate and Angle Columns.



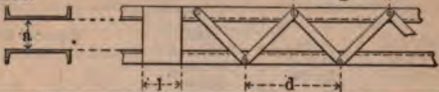

NOTE: Lug T applies to all connections. Reactions given are for Columns of $\frac{5}{16}$" metal and over; for ¼" metal, reduce reactions by 15 per cent. Rivets are assumed as ¾".

# Columns

**Continued**

## Lattice Bars and Tie Plates

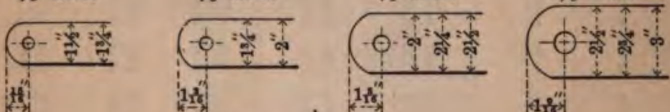
Table giving minimum sizes of lattice bars and tie plates used for channel struts.



| Depth of Channel, Inches | Back to Back of Channel "a," Inches | Section of Lattice Bars, Inches | Thickness of Tie Plates, Inches | Size of Rivet, Inches | Length of Tie Plates "l," Inches | Rivet Spacing "d" Maximum Feet | Maximum Inches | Minimum Feet | Minimum Inches |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 4 | 1½x¼ | ¼ | ½ | 7½ | 0 | 11½ | 0 | 6⅝ |
| 7 | 4¾ | 1¾x¼ | ¼ | ⅝ | 10 | 1 | 1½ | 0 | 7⅝ |
| 8 | 5½ | 2 x$\frac{5}{16}$ | $\frac{5}{16}$ | ¾ | 10 | 1 | 3 | 0 | 8$\frac{11}{16}$ |
| 9 | 6 | 2 x$\frac{5}{16}$ | $\frac{5}{16}$ | ¾ | 12 | 1 | 4½ | 0 | 9½ |
| 10 | 6¾ | 2 x⅜ | ⅜ | ¾ | 12 | 1 | 6½ | 0 | 10$\frac{11}{16}$ |
| 12 | 8¼ | 2¼x⅜ | ⅜ | ¾ | 15 | 1 | 10½ | 1 | 1 |
| 15 | 10¼ | 2½x⅜ | ⅜ | ¾ | 15 | 2 | 2½ | 1 | 3$\frac{5}{16}$ |

Sketches showing finished ends of lattice bars and clearance between same when cut from long bars.

**½" Rivet** **⅝" Rivet** **¾" Rivet** **⅞" Rivet**




$c$ = distance center to center of rivet holes.
$f = c + 2$ distances as per sketch above.
$e = f + h$.

In struts and columns carrying calculated stresses, the tie plates should be placed as near the ends as practicable, and at intermediate points where the lattice bars are not continuous. The end tie plates should have a length at least equal to the distance between lines of rivets connecting them to the flanges. These lattice bars should be capable of resisting a shearing stress equal to 2 per cent. of the direct stress. The thickness of lattice bars for single lattice should be at least 2½ per cent. of the distance between end rivets.

Rule for Latticing of Channels and Angles

$$d = \frac{r L}{R}$$

$d$ = Maximum length between lattice bars
$L$ = Total length of strut or column
$r$ = Least radius of gyration for a single channel
$R$ = Least radius of gyration for the whole secti[on]

# Columns

## Continued

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\,\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Depth of Beam, Inches | Weight per Foot, Pounds | Area, Square Inches | Least Radius of Gyration, Inches | Length in Feet | | |
|---|---|---|---|---|---|---|
| | | | | 3 | 4 | 5 |
| 24 | 100 | 29.41 | 1.28 | .......... | 393.4 | 374.1 |
| 24 | 80 | 23.32 | 1.36 | .......... | 315.5 | 301.1 |
| 20 | 100 | 29.41 | 1.34 | .......... | 396.8 | 378.4 |
| 20 | 80 | 23.73 | 1.39 | .......... | 322.3 | 308.0 |
| 20 | 65 | 19.08 | 1.21 | .......... | 252.3 | 239.1 |
| 18 | 70 | 20.59 | 1.09 | 281.8 | 266.0 | 250.1 |
| 18 | 55 | 15.93 | 1.15 | 220.0 | 208.3 | 196.7 |
| 15 | 60 | 17.67 | 1.21 | .......... | 233.7 | 221.4 |
| 15 | 42 | 12.48 | 1.08 | 170.6 | 160.9 | 151.1 |
| 12 | 55 | 16.18 | 1.04 | 219.7 | 206.6 | 193.5 |
| 12 | 40 | 11.84 | 1.08 | 161.8 | 152.6 | 143.4 |
| 12 | 31½ | 9.26 | 1.01 | 125.1 | 117.4 | 109.7 |
| 10 | 40 | 11.76 | 0.90 | 155.2 | 144.3 | 133.3 |
| 10 | 25 | 7.37 | 0.97 | 98.8 | 92.4 | 86.0 |
| 9 | 35 | 10.29 | 0.84 | 133.8 | 123.5 | 113.2 |
| 9 | 21 | 6.18 | 0.90 | 81.6 | 75.9 | 70.1 |
| 8 | 25½ | 7.50 | 0.80 | 96.4 | 88.5 | 80.6 |
| 8 | 18 | 5.33 | 0.84 | 69.3 | 64.0 | 58.6 |
| 7 | 20 | 5.88 | 0.74 | 74.1 | 67.4 | 60.7 |
| 7 | 15 | 4.42 | 0.78 | 56.4 | 51.7 | 46.9 |
| 6 | 17¼ | 5.07 | 0.68 | 62.3 | 56.1 | 49.8 |
| 6 | 12¼ | 3.61 | 0.72 | 45.1 | 40.9 | 36.7 |
| 5 | 14¾ | 4.34 | 0.63 | 52.1 | 46.3 | 40.5 |
| 5 | 9¾ | 2.87 | 0.65 | 34.8 | 31.1 | 27.4 |
| 4 | 10½ | 3.09 | 0.57 | 35.8 | 31.2 | 26.7 |
| 4 | 7½ | 2.21 | 0.59 | 25.9 | 22.8 | 19.6 |
| 3 | 7½ | 2.21 | 0.52 | 24.7 | 21.1 | 17.5 |
| 3 | 5½ | 1.63 | 0.53 | 18.3 | 15.7 | 13.2 |

This table continued on next page.

## Safe Loads in Thousands of Pounds
## For Single Beam Columns, Square Ends

| Length in Feet | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 |
| 354.8 | 335.5 | 316.2 | 296.9 | 277.6 | 239.0 | 200.4 | 161.8 |
| 286.7 | 272.3 | 257.9 | 243.5 | 229.1 | 200.3 | 171.5 | 142.7 |
| 359.9 | 341.5 | 323.1 | 304.6 | 286.2 | 249.3 | 212.5 | 175.6 |
| 293.6 | 279.3 | 264.9 | 250.6 | 236.3 | 207.6 | 178.9 | 150.2 |
| 225.8 | 212.6 | 199.3 | 186.1 | 172.8 | 146.3 | 119.8 | .......... |
| 234.2 | 218.4 | 202.5 | 186.6 | 170.8 | 139.0 | .......... | .......... |
| 185.1 | 173.4 | 161.8 | 150.2 | 138.5 | 115.3 | 92.0 | .......... |
| 209.1 | 196.9 | 184.6 | 172.3 | 160.1 | 135.5 | 111.0 | .......... |
| 141.4 | 131.7 | 122.0 | 112.3 | 102.6 | 83.2 | .......... | .......... |
| 180.5 | 167.4 | 154.3 | 141.3 | 128.2 | 102.1 | .......... | .......... |
| 134.2 | 125.0 | 115.8 | 106.6 | 97.4 | 78.9 | .......... | .......... |
| 102.0 | 94.3 | 86.6 | 78.9 | 71.1 | 55.7 | .......... | .......... |
| 122.3 | 111.3 | 100.4 | 89.4 | 78.4 | .......... | .......... | .......... |
| 79.6 | 73.2 | 66.9 | 60.5 | 54.1 | 41.3 | .......... | .......... |
| 102.9 | 92.6 | 82.3 | 72.0 | 61.7 | .......... | .......... | .......... |
| 64.3 | 58.5 | 52.8 | 47.0 | 41.3 | .......... | .......... | .......... |
| 72.8 | 64.9 | 57.0 | 49.1 | 41.3 | .......... | .......... | .......... |
| 53.3 | 48.0 | 42.6 | 37.3 | 32.0 | .......... | .......... | .......... |
| 54.0 | 47.4 | 40.7 | 34.0 | .......... | .......... | .......... | .......... |
| 42.2 | 37.4 | 32.6 | 27.9 | .......... | .......... | .......... | .......... |
| 43.5 | 37.3 | 31.0 | .......... | .......... | .......... | .......... | .......... |
| 32.5 | 28.3 | 24.1 | 19.9 | .......... | .......... | .......... | .......... |
| 34.7 | 28.9 | .......... | .......... | .......... | .......... | .......... | .......... |
| 23.7 | 20.0 | 16.2 | .......... | .......... | .......... | .......... | .......... |
| 22.1 | 17.6 | .......... | .......... | .......... | .......... | .......... | .......... |
| 16.5 | 13.3 | .......... | .......... | .......... | .......... | .......... | .......... |
| 13.9 | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| 10.6 | .......... | .......... | .......... | .......... | .......... | .......... | .......... |

# Columns

**Continued**

## Safe Loads in Thousands of Pounds for Plate and Angle Columns, Square Ends

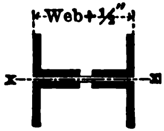
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.

$16{,}000-70\frac{l}{r}$ for lengths between 30 radii and 150 radii.

Short legs of angles riveted to web plates.
Column weights do not include rivets.

| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 |
| 3 x 2½ x ¼ | 6 x ¼ | ........ | 6.74 | 23.1 | 1.24 | 89.6 | 85.0 | 80.4 | 75.9 | 71.3 | 66.7 | 62.2 | 53.1 |
| 3 x 2½ x 5/16 | 6 x 5/16 | ........ | 8.36 | 28.8 | 1.27 | 111.6 | 106.1 | 100.6 | 95.1 | 89.5 | 84.0 | 78.5 | 67.4 |
| 3 x 2½ x ⅜ | 6 x ⅜ | ........ | 9.93 | 34.1 | 1.30 | 133.2 | 126.8 | 120.4 | 114.0 | 107.6 | 101.1 | 94.7 | 81.9 |
| 3 x 2½ x 7/16 | 6 x 7/16 | ........ | 11.47 | 39.3 | 1.33 | 154.5 | 147.3 | 140.1 | 132.8 | 125.6 | 118.3 | 111.1 | 96.6 |
| 4 x 3 x 5/16 | 8 x 5/16 | ........ | 10.86 | 37.3 | 1.67 | ...... | ...... | 141.0 | 135.5 | 130.1 | 124.6 | 119.1 | 108.2 |
| 4 x 3 x ⅜ | 8 x ⅜ | ........ | 12.92 | 44.2 | 1.70 | ...... | ...... | 168.4 | 162.0 | 155.6 | 149.3 | 142.9 | 130.1 |
| 4 x 3 x 7/16 | 8 x 7/16 | ........ | 14.98 | 51.1 | 1.73 | ...... | ...... | 196.0 | 188.8 | 181.5 | 174.2 | 166.9 | 152.4 |
| 4 x 3 x ½ | 8 x ½ | ........ | 17.00 | 58.0 | 1.76 | ...... | ...... | 223.3 | 215.2 | 207.1 | 199.0 | 190.9 | 174.6 |
| 4 x 3 x 9/16 | 8 x 9/16 | ........ | 18.98 | 64.9 | 1.79 | ...... | ...... | 250.2 | 241.3 | 232.4 | 223.5 | 214.6 | 196.8 |
| 5 x 3½ x 5/16 | 10 x 5/16 | ........ | 13.37 | 45.4 | 2.08 | ...... | ...... | 181.5 | 176.1 | 170.7 | 165.3 | 159.9 | 149.1 |
| 5 x 3½ x ⅜ | 10 x ⅜ | ........ | 15.95 | 54.4 | 2.10 | ...... | ...... | 216.9 | 210.5 | 204.2 | 197.8 | 191.4 | 178.6 |
| 5 x 3½ x 7/16 | 10 x 7/16 | ........ | 18.50 | 62.9 | 2.13 | ...... | ...... | 252.2 | 244.9 | 237.6 | 230.3 | 223.0 | 208.5 |
| 5 x 3½ x ½ | 10 x ½ | ........ | 21.00 | 71.4 | 2.16 | ...... | ...... | 287.0 | 278.8 | 270.7 | 262.5 | 254.3 | 238.0 |
| 5 x 3½ x 9/16 | 10 x 9/16 | ........ | 23.51 | 79.9 | 2.19 | ...... | ...... | 322.1 | 313.0 | 304.0 | 295.0 | 286.0 | 268.0 |
| 5 x 3½ x ⅝ | 10 x ⅝ | ........ | 25.93 | 88.5 | 2.22 | ...... | ...... | 356.0 | 346.2 | 336.4 | 326.6 | 316.8 | 297.1 |
| 5 x 3½ x 11/16 | 10 x 11/16 | ........ | 28.36 | 96.6 | 2.25 | ...... | ...... | 390.2 | 379.6 | 369.1 | 358.5 | 347.9 | 326.7 |
| 5 x 3½ x ¾ | 10 x ¾ | ........ | 30.74 | 104.7 | 2.29 | ...... | ...... | 424.2 | 412.9 | 401.6 | 390.4 | 379.1 | 356.5 |

This table continued below.




| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 x 2½ x ¼ | 6 x ¼ | ........ | 6.74 | 23.1 | 1.24 | 44.0 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 x 2½ x 5/16 | 6 x 5/16 | ........ | 8.36 | 28.8 | 1.27 | 56.3 | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 x 2½ x ⅜ | 6 x ⅜ | ........ | 9.93 | 34.1 | 1.30 | 69.1 | 56.2 | ..... | ..... | ..... | ..... | ..... | ..... |
| 3 x 2½ x 7/16 | 6 x 7/16 | ........ | 11.47 | 39.3 | 1.33 | 82.1 | 67.6 | ..... | ..... | ..... | ..... | ..... | ..... |
| 4 x 3 x 5/16 | 8 x 5/16 | ........ | 10.86 | 37.3 | 1.67 | 97.3 | 86.4 | 75.4 | 64.5 | ..... | ..... | ..... | ..... |
| 4 x 3 x ⅜ | 8 x ⅜ | ........ | 12.92 | 44.2 | 1.70 | 117.3 | 104.6 | 91.8 | 79.0 | ..... | ..... | ..... | ..... |
| 4 x 3 x 7/16 | 8 x 7/16 | ........ | 14.98 | 51.1 | 1.73 | 137.9 | 123.3 | 108.8 | 94.2 | ..... | ..... | ..... | ..... |
| 4 x 3 x ½ | 8 x ½ | ........ | 17.00 | 58.0 | 1.76 | 158.4 | 142.2 | 126.0 | 109.7 | 93.5 | ..... | ..... | ..... |
| 4 x 3 x 9/16 | 8 x 9/16 | ........ | 18.98 | 64.9 | 1.79 | 179.0 | 161.2 | 143.4 | 125.5 | 107.7 | ..... | ..... | ..... |
| 5 x 3½ x 5/16 | 10 x 5/16 | ........ | 13.37 | 45.4 | 2.08 | 138.3 | 127.5 | 116.7 | 105.9 | 95.1 | 84.3 | 73.5 | ..... |
| 5 x 3½ x ⅜ | 10 x ⅜ | ........ | 15.95 | 54.4 | 2.10 | 165.9 | 153.1 | 140.4 | 127.6 | 114.8 | 102.1 | 89.3 | ..... |
| 5 x 3½ x 7/16 | 10 x 7/16 | ........ | 18.50 | 62.9 | 2.13 | 193.9 | 179.3 | 164.7 | 150.1 | 135.5 | 120.9 | 106.3 | ..... |
| 5 x 3½ x ½ | 10 x ½ | ........ | 21.00 | 71.4 | 2.16 | 221.6 | 205.3 | 189.0 | 172.6 | 156.3 | 139.9 | 123.6 | ..... |
| 5 x 3½ x 9/16 | 10 x 9/16 | ........ | 23.51 | 79.9 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# Columns

**Continued**

## Safe Load in Thousands of Pounds for Plate and Angle Columns, Square Ends

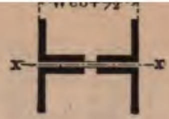
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.

$16{,}000-70\frac{1}{r}$ for lengths between 30 radii and 150 radii.

Short legs of angles riveted to web plates.
Column weights do not include rivets.

| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 x 6 x 1/2 | 14 x 1/2 | ...... | 34.00 | 115.6 | 3.33 | 466.8 | 458.2 | 441.1 | 423.9 | 406.8 | 389.6 | 372.5 | 355.3 | 338.1 |
| 8 x 6 x 9/16 | 14 x 9/16 | ...... | 38.12 | 129.6 | 3.36 | 524.2 | 514.6 | 495.5 | 476.5 | 457.4 | 438.4 | 419.3 | 400.2 | 381.2 |
| 8 x 6 x 5/8 | 14 x 5/8 | ...... | 42.19 | 143.4 | 3.39 | 581.0 | 570.5 | 549.6 | 528.7 | 507.8 | 486.9 | 466.0 | 445.0 | 424.1 |
| 8 x 6 x 11/16 | 14 x 11/16 | ...... | 46.23 | 157.2 | 3.42 | 637.5 | 626.1 | 603.4 | 580.7 | 558.0 | 535.3 | 512.6 | 489.9 | 467.2 |
| 8 x 6 x 3/4 | 14 x 3/4 | ...... | 50.26 | 170.9 | 3.45 | 694.0 | 681.8 | 657.3 | 632.8 | 608.4 | 583.9 | 559.4 | 535.0 | 510.5 |
| 8 x 6 x 13/16 | 14 x 13/16 | ...... | 54.26 | 184.5 | 3.48 | 750.3 | 737.2 | 711.0 | 684.8 | 658.6 | 632.4 | 606.2 | 580.0 | 553.8 |
| 8 x 6 x 7/8 | 14 x 7/8 | ...... | 58.17 | 197.8 | 3.51 | 805.4 | 791.5 | 763.7 | 735.8 | 708.0 | 680.1 | 652.3 | 624.5 | 596.6 |
| 8 x 6 x 15/16 | 14 x 15/16 | ...... | 62.13 | 211.2 | 3.54 | 861.4 | 846.7 | 817.2 | 787.7 | 758.2 | 728.7 | 699.2 | 669.7 | 640.3 |
| 8 x 6 x 1 | 14 x 1 | ...... | 66.00 | 224.4 | 3.57 | 916.2 | 900.7 | 869.7 | 838.6 | 807.5 | 776.5 | 745.4 | 714.4 | 683.3 |
| 8 x 6 x 3/4 | 16 x 3/4 | 18 x 1/2 | 69.76 | 237.2 | 3.94 | ...... | 967.4 | 937.7 | 908.0 | 878.2 | 848.5 | 818.7 | 789.0 | 759.3 |
| 8 x 6 x 7/8 | 16 x 7/8 | 18 x 1/2 | 77.92 | 264.9 | 3.93 | ...... | 1080.2 | 1046.9 | 1013.6 | 980.2 | 946.9 | 913.6 | 880.3 | 847.0 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1/2 | 86.00 | 292.4 | 3.93 | ...... | 1192.2 | 1155.4 | 1118.7 | 1081.9 | 1045.1 | 1008.4 | 971.6 | 934.8 |
| 8 x 6 x 1 | 16 x 1 | 18 x 5/8 | 90.50 | 307.7 | 4.00 | ...... | 1258.0 | 1219.9 | 1181.9 | 1143.9 | 1105.9 | 1067.9 | 1029.9 | 991.9 |
| 8 x 6 x 1 | 16 x 1 | 18 x 3/4 | 95.00 | 323.0 | 4.06 | ...... | ...... | 1284.1 | 1244.8 | 1205.5 | 1166.2 | 1126.9 | 1087.6 | 1048.3 |
| 8 x 6 x 1 | 16 x 1 | 18 x 7/8 | 99.50 | 338.3 | 4.12 | ...... | ...... | 1348.6 | 1308.0 | 1267.4 | 1226.9 | 1186.3 | 1145.7 | 1105.1 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 | 104.00 | 353.6 | 4.17 | ...... | ...... | 1412.6 | 1370.7 | 1328.8 | 1286.9 | 1245.0 | 1203.1 | 1161.2 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 1/8 | 108.50 | 368.9 | 4.22 | ...... | ...... | 1476.8 | 1433.6 | 1390.5 | 1347.3 | 1304.1 | 1260.9 | 1217.7 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 1/4 | 113.00 | 384.2 | 4.26 | ...... | ...... | 1540.6 | 1496.1 | 1451.5 | 1406.9 | 1362.4 | 1317.8 | 1273.2 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 3/8 | 117.50 | 399.5 | 4.30 | ...... | ...... | 1604.6 | 1558.7 | 1512.8 | 1466.9 | 1420.9 | 1375.0 | 1329.1 |

This table continued below.



| Size of Angles Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | ...... |
| 8 x 6 x ½ | 14 x ½ | .............. | 34.00 | 115.6 | 3.33 | 321.0 | 303.8 | 286.7 | 269.5 | 252.4 | 235.2 | 218.1 | 200.9 | ...... |
| 8 x 6 x 9/16 | 14 x 9/16 | .............. | 38.12 | 129.6 | 3.36 | 362.1 | 343.0 | 324.0 | 304.9 | 285.9 | 266.8 | 247.7 | 228.7 | ...... |
| 8 x 6 x ⅝ | 14 x ⅝ | .............. | 42.19 | 143.4 | 3.39 | 403.2 | 382.3 | 361.4 | 340.5 | 319.6 | 298.7 | 277.8 | 256.9 | ...... |
| 8 x 6 x 11/16 | 14 x 11/16 | .............. | 46.23 | 157.2 | 3.42 | 444.5 | 421.7 | 399.0 | 376.3 | 353.6 | 330.9 | 308.2 | 285.5 | ...... |
| 8 x 6 x ¾ | 14 x ¾ | .............. | 50.26 | 170.9 | 3.45 | 486.0 | 461.5 | 437.1 | 412.6 | 388.1 | 363.7 | 339.2 | 314.7 | ...... |
| 8 x 6 x 13/16 | 14 x 13/16 | .............. | 54.26 | 184.5 | 3.48 | 527.7 | 501.5 | 475.3 | 449.1 | 422.9 | 396.7 | 370.5 | 344.3 | ...... |
| 8 x 6 x ⅞ | 14 x ⅞ | .............. | 58.17 | 197.8 | 3.51 | 568.8 | 540.9 | 513.1 | 485.2 | 457.4 | 429.6 | 401.7 | 373.9 | ...... |
| 8 x 6 x 15/16 | 14 x 15/16 | .............. | 62.13 | 211.2 | 3.54 | 610.8 | 581.3 | 551.8 | 522.3 | 492.8 | 463.3 | 433.9 | 404.4 | ...... |
| 8 x 6 x 1 | 14 x 1 | .............. | 66.00 | 224.4 | 3.57 | 652.3 | 621.2 | 590.2 | 559.1 | 528.0 | 497.0 | 465.9 | 434.9 | ...... |
| 8 x 6 x ¾ | 16 x ¾ | 18 x ½ | 69.76 | 237.2 | 3.94 | 729.5 | 699.8 | 670.1 | 640.3 | 610.6 | 580.8 | 551.1 | 521.4 | ...... |
| 8 x 6 x ⅞ | 16 x ⅞ | 18 x ½ | 77.92 | 264.9 | 3.93 | 813.7 | 780.4 | 747.1 | 713.8 | 680.5 | 647.1 | 613.8 | 580.5 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ½ | 86.00 | 292.4 | 3.93 | 898.1 | 861.3 | 824.5 | 787.8 | 751.0 | 714.3 | 677.5 | 640.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅝ | 90.50 | 307.7 | 4.00 | 953.9 | 915.9 | 877.9 | 839.8 | 801.8 | 763.8 | 725.8 | 687.8 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ¾ | 95.00 | 323.0 | 4.06 | 1008.9 | 969.6 | 930.3 | 891.0 | 851.7 | 812.4 | 773.1 | 733.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅞ | 99.50 | 338.3 | 4.12 | 1064.6 | 1024.0 | 983.4 | 942.9 | 902.3 | 861.7 | 821.1 | 780.6 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 | 104.00 | 353.6 | 4.17 | 1119.3 | 1077.4 | 1035.5 | 993.6 | 951.8 | 909.9 | 868.0 | 826.1 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅛ | 108.50 | 368.9 | 4.22 | 1174.5 | 1131.3 | 1088.1 | 1044.9 | 1001.7 | 958.5 | 915.3 | 872.1 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1¼ | 113.00 | 384.2 | 4.26 | 1228.7 | 1184.1 | 1139.5 | 1095.0 | 1050.4 | 1005.9 | 961.3 | 916.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅜ | 117.50 | 399.5 | 4.30 | 1283.2 | 1237.3 | 1191.4 | 1145.5 | 1099.6 | 1053.7 | 1007.8 | 961.9 | ...... |

This table continued on next page.

# Columns

**Continued**

## Safe Load in Thousands of Pounds for Plate and Angle Columns, Square Ends

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.

$16{,}000-70\frac{1}{r}$ for lengths between 30 radii and 150 radii.

Short legs of angles riveted to web plates.
Column weights do not include rivets.

| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet: 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 x 6 x ½ | 14 x ½ | ...... | 34.00 | 115.6 | 3.33 | 466.8 | 458.2 | 441.1 | 423.9 | 406.8 | 389.6 | 372.5 | 355.3 | 338.1 |
| 8 x 6 x 9/16 | 14 x 9/16 | ...... | 38.12 | 129.6 | 3.36 | 524.2 | 514.6 | 495.5 | 476.5 | 457.4 | 438.4 | 419.3 | 400.2 | 381.2 |
| 8 x 6 x ⅝ | 14 x ⅝ | ...... | 42.19 | 143.4 | 3.39 | 581.0 | 570.5 | 549.6 | 528.7 | 507.8 | 486.9 | 466.0 | 445.0 | 424.1 |
| 8 x 6 x 11/16 | 14 x 11/16 | ...... | 46.23 | 157.2 | 3.42 | 637.5 | 626.1 | 603.4 | 580.7 | 558.0 | 535.3 | 512.6 | 489.9 | 467.2 |
| 8 x 6 x ¾ | 14 x ¾ | ...... | 50.26 | 170.9 | 3.45 | 694.0 | 681.8 | 657.3 | 632.8 | 608.4 | 583.9 | 559.4 | 535.0 | 510.5 |
| 8 x 6 x 13/16 | 14 x 13/16 | ...... | 54.26 | 184.5 | 3.48 | 750.3 | 737.2 | 711.0 | 684.8 | 658.6 | 632.4 | 606.2 | 580.0 | 553.8 |
| 8 x 6 x ⅞ | 14 x ⅞ | ...... | 58.17 | 197.8 | 3.51 | 805.4 | 791.5 | 763.7 | 735.8 | 708.0 | 680.1 | 652.3 | 624.5 | 596.6 |
| 8 x 6 x 15/16 | 14 x 15/16 | ...... | 62.13 | 211.2 | 3.54 | 861.4 | 846.7 | 817.2 | 787.7 | 758.2 | 728.7 | 699.2 | 669.7 | 640.3 |
| 8 x 6 x 1 | 14 x 1 | ...... | 66.00 | 224.4 | 3.57 | 916.2 | 900.7 | 869.7 | 838.6 | 807.5 | 776.5 | 745.4 | 714.4 | 683.3 |
| 8 x 6 x ¾ | 16 x ¾ | 18 x ½ | 69.76 | 237.2 | 3.94 | ...... | 967.4 | 937.7 | 908.0 | 878.2 | 848.5 | 818.7 | 789.0 | 759.3 |
| 8 x 6 x ⅞ | 16 x ⅞ | 18 x ½ | 77.92 | 264.9 | 3.93 | ...... | 1080.2 | 1046.9 | 1013.6 | 980.2 | 946.9 | 913.6 | 880.3 | 847.0 |
| 8 x 6 x 1 | 16 x 1 | 18 x ½ | 86.00 | 292.4 | 3.93 | ...... | 1192.2 | 1155.4 | 1118.7 | 1081.9 | 1045.1 | 1008.4 | 971.6 | 934.8 |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅝ | 90.50 | 307.7 | 4.00 | ...... | 1258.0 | 1219.9 | 1181.9 | 1143.9 | 1105.9 | 1067.9 | 1029.9 | 991.9 |
| 8 x 6 x 1 | 16 x 1 | 18 x ¾ | 95.00 | 323.0 | 4.06 | ...... | ...... | 1284.1 | 1244.8 | 1205.5 | 1166.2 | 1126.9 | 1087.6 | 1048.3 |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅞ | 99.50 | 338.3 | 4.12 | ...... | ...... | 1348.6 | 1308.0 | 1267.4 | 1226.9 | 1186.3 | 1145.7 | 1105.1 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 | 104.00 | 353.6 | 4.17 | ...... | ...... | 1412.6 | 1370.7 | 1328.8 | 1286.9 | 1245.0 | 1203.1 | 1161.2 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅛ | 108.50 | 368.9 | 4.22 | ...... | ...... | 1476.8 | 1433.6 | 1390.5 | 1347.3 | 1304.1 | 1260.9 | 1217.7 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1¼ | 113.00 | 384.2 | 4.26 | ...... | ...... | 1540.6 | 1496.1 | 1451.5 | 1406.9 | 1362.4 | 1317.8 | 1273.2 |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅜ | 117.50 | 399.5 | 4.30 | ...... | ...... | 1604.6 | 1558.7 | 1512.8 | 1466.9 | 1420.9 | 1375.0 | 1329.1 |

This table continued below.

| Size of Angles Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | ...... |
| 8 x 6 x ½ | 14 x ½ | ............ | 34.00 | 115.6 | 3.33 | 321.0 | 303.8 | 286.7 | 269.5 | 252.4 | 235.2 | 218.1 | 200.9 | ...... |
| 8 x 6 x 9/16 | 14 x 9/16 | ............ | 38.12 | 129.6 | 3.36 | 362.1 | 343.0 | 324.0 | 304.9 | 285.9 | 266.8 | 247.7 | 228.7 | ...... |
| 8 x 6 x ⅝ | 14 x ⅝ | ............ | 42.19 | 143.4 | 3.39 | 403.2 | 382.3 | 361.4 | 340.5 | 319.6 | 298.7 | 277.8 | 256.9 | ...... |
| 8 x 6 x 11/16 | 14 x 11/16 | ............ | 46.23 | 157.2 | 3.42 | 444.5 | 421.7 | 399.0 | 376.3 | 353.6 | 330.9 | 308.2 | 285.5 | ...... |
| 8 x 6 x ¾ | 14 x ¾ | ............ | 50.26 | 170.9 | 3.45 | 486.0 | 461.5 | 437.1 | 412.6 | 388.1 | 363.7 | 339.2 | 314.7 | ...... |
| 8 x 6 x 13/16 | 14 x 13/16 | ............ | 54.26 | 184.5 | 3.48 | 527.7 | 501.5 | 475.3 | 449.1 | 422.9 | 396.7 | 370.5 | 344.3 | ...... |
| 8 x 6 x ⅞ | 14 x ⅞ | ............ | 58.17 | 197.8 | 3.51 | 568.8 | 540.9 | 513.1 | 485.2 | 457.4 | 429.6 | 401.7 | 373.9 | ...... |
| 8 x 6 x 15/16 | 14 x 15/16 | ............ | 62.13 | 211.2 | 3.54 | 610.8 | 581.3 | 551.8 | 522.3 | 492.8 | 463.3 | 433.9 | 404.4 | ...... |
| 8 x 6 x 1 | 14 x 1 | ............ | 66.00 | 224.4 | 3.57 | 652.3 | 621.2 | 590.2 | 559.1 | 528.0 | 497.0 | 465.9 | 434.9 | ...... |
| 8 x 6 x ¾ | 16 x ¾ | 18 x ½ | 69.76 | 237.2 | 3.94 | 729.5 | 699.8 | 670.1 | 640.3 | 610.6 | 580.8 | 551.1 | 521.4 | ...... |
| 8 x 6 x ⅞ | 16 x ⅞ | 18 x ½ | 77.92 | 264.9 | 3.93 | 813.7 | 780.4 | 747.1 | 713.8 | 680.5 | 647.1 | 613.8 | 580.5 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ½ | 86.00 | 292.4 | 3.93 | 898.1 | 861.3 | 824.5 | 787.8 | 751.0 | 714.3 | 677.5 | 640.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅝ | 90.50 | 307.7 | 4.00 | 953.9 | 915.9 | 877.9 | 839.8 | 801.8 | 763.8 | 725.8 | 687.8 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ¾ | 95.00 | 323.0 | 4.06 | 1008.9 | 969.6 | 930.3 | 891.0 | 851.7 | 812.4 | 773.1 | 733.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x ⅞ | 99.50 | 338.3 | 4.12 | 1064.6 | 1024.0 | 983.4 | 942.9 | 902.3 | 861.7 | 821.1 | 780.6 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1 | 104.00 | 353.6 | 4.17 | 1119.3 | 1077.4 | 1035.5 | 993.6 | 951.8 | 909.9 | 868.0 | 826.1 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅛ | 108.50 | 368.9 | 4.22 | 1174.5 | 1131.3 | 1088.1 | 1044.9 | 1001.7 | 958.5 | 915.3 | 872.1 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1¼ | 113.00 | 384.2 | 4.26 | 1228.7 | 1184.1 | 1139.5 | 1095.0 | 1050.4 | 1005.9 | 961.3 | 916.7 | ...... |
| 8 x 6 x 1 | 16 x 1 | 18 x 1⅜ | 117.50 | 399.5 | 4.30 | 1283.2 | 1237.3 | 1191.4 | 1145.5 | 1099.6 | 1053.7 | 1007.8 | 961.9 | ...... |

This table continued on next page.

# Columns

## Continued

## Safe Loads in Thousands of Pounds for Plate and Angle Columns, Square Ends

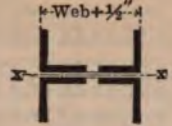
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.

$16{,}000-70\frac{l}{r}$ for lengths between 30 radii and 150 radii.

Short legs of angles riveted to web plates.
Column weights do not include rivets.

| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 x 6 x 1 | 16 x 1½ | 18 x 1½ | 130.00 | 442.0 | 4.28 | ...... | ...... | 1773.8 | 1722.8 | 1671.8 | 1620.7 | 1569.7 | 1518.7 | 1467.6 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1⅝ | 134.50 | 457.3 | 4.32 | ...... | ...... | 1838.2 | 1785.9 | 1733.6 | 1681.3 | 1629.0 | 1576.7 | 1524.4 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1¾ | 139.00 | 472.6 | 4.35 | ...... | ...... | 1901.9 | 1848.2 | 1794.5 | 1740.9 | 1687.2 | 1633.5 | 1579.8 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1⅞ | 143.50 | 487.9 | 4.38 | ...... | ...... | 1965.8 | 1910.7 | 1855.7 | 1800.6 | 1745.6 | 1690.5 | 1635.5 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2 | 148.00 | 503.2 | 4.41 | ...... | ...... | 2029.7 | 1973.3 | 1917.0 | 1860.6 | 1804.2 | 1747.8 | 1691.4 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅛ | 152.50 | 518.5 | 4.43 | ...... | ...... | 2093.0 | 2035.2 | 1977.3 | 1919.5 | 1861.7 | 1803.8 | 1746.0 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2¼ | 157.00 | 533.8 | 4.45 | ...... | ...... | 2156.4 | 2097.1 | 2037.8 | 1978.6 | 1919.3 | 1860.0 | 1800.8 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅜ | 161.50 | 549.1 | 4.48 | ...... | ...... | 2220.6 | 2160.1 | 2099.5 | 2038.9 | 1978.3 | 1917.8 | 1857.2 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2½ | 166.00 | 564.4 | 4.50 | ...... | ...... | 2284.2 | 2222.2 | 2160.2 | 2098.3 | 2036.3 | 1974.3 | 1912.3 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅝ | 170.50 | 579.7 | 4.52 | ...... | ...... | 2347.8 | 2284.4 | 2221.0 | 2157.7 | 2094.3 | 2030.9 | 1967.5 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2¾ | 175.00 | 595.0 | 4.54 | ...... | ...... | 2411.5 | 2346.7 | 2281.9 | 2217.2 | 2152.4 | 2087.7 | 2022.9 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅞ | 179.50 | 610.3 | 4.55 | ...... | ...... | 2474.3 | 2408.1 | 2341.8 | 2275.5 | 2209.2 | 2142.9 | 2076.7 |
| 8 x 6 x 1 | 16 x 1½ | 18 x 3 | 184.00 | 625.6 | 4.57 | ...... | ...... | 2538.2 | 2470.5 | 2402.9 | 2335.2 | 2267.6 | 2199.9 | 2132.3 |

This table continued below.




| Size of Angles, Inches | Size of Web Plates, Inches | Size of Cover Plates, Inches | Area of Column, Square Inches | Weight Per Foot of Column, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1½ | 130.00 | 442.0 | 4.28 | 1416.6 | 1365.6 | 1314.6 | 1263.5 | 1212.5 | 1161.4 | 1110.4 | 1059.4 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1⅝ | 134.50 | 457.3 | 4.32 | 1472.1 | 1419.8 | 1367.5 | 1315.2 | 1262.9 | 1210.6 | 1158.3 | 1106.0 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1¾ | 139.00 | 472.6 | 4.35 | 1526.1 | 1472.5 | 1418.8 | 1365.1 | 1311.4 | 1257.7 | 1204.1 | 1150.4 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 1⅞ | 143.50 | 487.9 | 4.38 | 1580.4 | 1525.4 | 1470.3 | 1415.3 | 1360.3 | 1305.2 | 1250.2 | 1195.1 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2 | 148.00 | 503.2 | 4.41 | 1635.1 | 1578.7 | 1522.3 | 1465.9 | 1409.6 | 1353.2 | 1296.8 | 1240.4 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅛ | 152.50 | 518.5 | 4.43 | 1688.1 | 1630.3 | 1572.5 | 1514.6 | 1456.8 | 1399.0 | 1341.1 | 1283.3 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2¼ | 157.00 | 533.8 | 4.45 | 1741.5 | 1682.2 | 1623.0 | 1563.7 | 1504.4 | 1445.1 | 1385.9 | 1326.6 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅜ | 161.50 | 549.1 | 4.48 | 1796.6 | 1736.1 | 1675.5 | 1614.9 | 1554.5 | 1493.8 | 1433.2 | 1372.8 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2½ | 166.00 | 564.4 | 4.50 | 1850.4 | 1788.4 | 1726.4 | 1664.5 | 1602.5 | 1540.5 | 1478.6 | 1416.6 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅝ | 170.50 | 579.7 | 4.52 | 1904.2 | 1840.8 | 1777.4 | 1714.0 | 1650.7 | 1587.3 | 1523.9 | 1460.5 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2¾ | 175.00 | 595.0 | 4.54 | 1958.2 | 1893.4 | 1828.7 | 1763.9 | 1699.2 | 1634.4 | 1569.7 | 1504.9 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 2⅞ | 179.50 | 610.3 | 4.55 | 2010.4 | 1944.1 | 1877.8 | 1811.5 | 1745.3 | 1679.0 | 1612.7 | 1546.4 | ...... |
| 8 x 6 x 1 | 16 x 1½ | 18 x 3 | 184.00 | 625.6 | 4.57 | 2064.6 | 1997.0 | 1929.4 | 1861.7 | 1794.1 | 1726.4 | 1658.8 | 1591.1 | ...... |

# Columns

## Continued

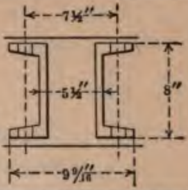
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\,\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Size of Channels | Size of Plates | Area, Square Inches | Weight per Linear Foot, Pounds | Least Radius of Gyration, Inches | Length in Feet 8 | 9 | 10 | 12 | 14 |
|---|---|---|---|---|---|---|---|---|---|
| 2-8″—11¼ lbs. | Lattice | 6.70 | 29.5 | 3.11 | 92.7 | 90.9 | 89.1 | 85.5 | 81.9 |
| | 2-10x¼ | 11.70 | 39.5 | 3.05 | 161.4 | 158.2 | 154.9 | 148.5 | 142.1 |
| | 2-10x5/16 | 12.95 | 43.8 | 3.04 | 178.6 | 175.0 | 171.4 | 164.3 | 157.1 |
| | 2-10x⅜ | 14.20 | 48.0 | 3.02 | 195.6 | 191.7 | 187.7 | 179.8 | 171.9 |
| | 2-10x7/16 | 15.45 | 52.3 | 3.01 | 212.7 | 208.4 | 204.1 | 195.5 | 186.8 |
| | 2-10x½ | 16.70 | 56.5 | 3.00 | 229.8 | 225.2 | 220.5 | 211.1 | 201.8 |
| | 2-10x9/16 | 17.95 | 60.8 | 2.99 | 246.9 | 241.8 | 236.8 | 226.7 | 216.6 |
| | 2-10x⅝ | 19.20 | 65.0 | 2.99 | 264.1 | 258.7 | 253.3 | 242.5 | 231.7 |
| 2-8″—13¾ lbs. | Lattice | 8.08 | 34.5 | 2.98 | 111.1 | 108.8 | 106.5 | 102.0 | 97.4 |
| | 2-10x¼ | 13.08 | 44.5 | 3.00 | 180.0 | 176.3 | 172.7 | 165.3 | 158.0 |
| | 2-10x5/16 | 14.33 | 48.8 | 2.99 | 197.1 | 193.0 | 189.0 | 181.0 | 172.9 |
| | 2-10x⅜ | 15.58 | 53.0 | 2.98 | 214.2 | 209.8 | 205.4 | 196.6 | 187.8 |
| | 2-10x7/16 | 16.83 | 57.3 | 2.97 | 231.2 | 226.4 | 221.7 | 212.2 | 202.6 |
| | 2-10x½ | 18.08 | 61.5 | 2.97 | 248.4 | 243.3 | 238.1 | 227.9 | 217.7 |
| | 2-10x9/16 | 19.33 | 65.8 | 2.96 | 265.4 | 259.9 | 254.4 | 243.5 | 232.5 |
| | 2-10x⅝ | 20.58 | 70.0 | 2.96 | 282.6 | 276.7 | 270.9 | 259.2 | 247.5 |
| 2-8″—16¼ lbs. | Lattice | 9.56 | 39.5 | 2.89 | 130.7 | 128.0 | 125.2 | 119.6 | 114.1 |
| | 2-10x⅜ | 17.06 | 58.0 | 2.93 | 233.8 | 228.9 | 224.1 | 214.3 | 204.5 |
| | 2-10x7/16 | 18.31 | 62.3 | 2.93 | 251.0 | 245.7 | 240.5 | 230.0 | 219.5 |
| | 2-10x½ | 19.56 | 66.5 | 2.93 | 268.1 | 262.5 | 256.9 | 245.7 | 234.5 |
| | 2-10x9/16 | 20.81 | 70.8 | 2.93 | 285.2 | 279.3 | 273.3 | 261.4 | 249.4 |
| | 2-10x⅝ | 22.06 | 75.0 | 2.92 | 302.2 | 295.9 | 289.5 | 276.8 | 264.7 |
| | 2-10x11/16 | 23.31 | 79.3 | 2.92 | 319.3 | 312.6 | 305.9 | 292.5 | 279.7 |
| | 2-10x¾ | 24.56 | 83.5 | 2.92 | 336.4 | 329.4 | 322.3 | 308.2 | 294.1 |
| 2-8″—18¾ lbs. | Lattice | 11.02 | 44.5 | 2.82 | 150.1 | 146.8 | 143.5 | 136.9 | 130.4 |
| | 2-10x⅜ | 18.52 | 63.0 | 2.89 | 253.3 | 247.9 | 242.5 | 231.7 | 221.0 |
| | 2-10x½ | 21.02 | 71.5 | 2.89 | 287.4 | 281.3 | 275.2 | 263.0 | 250.8 |
| | 2-10x⅝ | 23.52 | 80.0 | 2.89 | 321.6 | 314.8 | 308.0 | 294.3 | 280.6 |
| | 2-10x¾ | 26.02 | 88.5 | 2.89 | 355.8 | 348.3 | 340.7 | 325.6 | 310.4 |
| 2-8″—21¼ lbs. | Lattice | 12.50 | 49.5 | 2.77 | 169.7 | 165.9 | 162.1 | 154.5 | 146.9 |
| | 2-10x⅜ | 20.00 | 68.0 | 2.84 | 272.7 | 266.8 | 260.8 | 249.0 | 237.2 |
| | 2-10x½ | 22.50 | 76.5 | 2.84 | 306.8 | 300.1 | 293.5 | 280.1 | 266.8 |
| | 2-10x⅝ | 25.00 | 85.0 | 2.85 | 341.1 | 333.7 | 326.3 | 311.6 | 296.9 |
| | 2-10x¾ | 27.50 | 93.5 | 2.85 | 375.2 | 367.1 | 359.0 | 342.8 | 326.6 |
| | 2-10x⅞ | 30.00 | 102.0 | 2.86 | 409.5 | 400.7 | 391.9 | 374.3 | 356.7 |

This table continued on next page.

## Safe Loads in Thousands of Pounds
## For 2–8″ Channel Columns, Square Ends

Section 2–8″ Channels laced with 1¾″x5/16″ Bars or 2–8″ Channels and 2–10″ Plates. Holes 13/16″; Rivets ¾″ diameter. Column weights do not include Rivets.




**Length in Feet**

| 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 78.2 | 74.6 | 71.0 | 67.4 | 63.8 | 60.2 | 56.5 | 52.9 | 49.3 | 45.7 | 42.1 | 38.4 | ...... |
| 135.6 | 129.2 | 122.7 | 116.3 | 109.8 | 103.4 | 96.9 | 90.5 | 84.0 | 77.6 | 71.1 | 64.7 | ...... |
| 150.0 | 142.8 | 135.6 | 128.5 | 121.3 | 114.2 | 107.0 | 99.9 | 92.7 | 85.5 | 78.4 | 71.2 | ...... |
| 164.0 | 156.1 | 148.2 | 140.3 | 132.4 | 124.5 | 116.6 | 108.7 | 100.8 | 92.9 | 85.0 | ...... | ...... |
| 178.2 | 169.6 | 161.0 | 152.3 | 143.7 | 135.1 | 126.5 | 117.9 | 109.2 | 100.6 | 92.0 | ...... | ...... |
| 192.4 | 183.1 | 173.7 | 164.4 | 155.0 | 145.6 | 136.3 | 127.0 | 117.6 | 108.3 | 98.9 | ...... | ...... |
| 206.5 | 196.4 | 186.3 | 176.3 | 166.2 | 156.1 | 146.0 | 135.9 | 125.8 | 115.7 | 105.7 | ...... | ...... |
| 220.9 | 210.1 | 199.3 | 188.5 | 177.7 | 167.0 | 156.2 | 145.4 | 134.6 | 123.8 | 113.0 | ...... | ...... |
| 92.8 | 88.3 | 83.7 | 79.2 | 74.6 | 70.1 | 65.5 | 61.0 | 56.4 | 51.8 | 47.3 | ...... | ...... |
| 150.7 | 143.4 | 136.0 | 128.7 | 121.4 | 114.1 | 106.7 | 99.4 | 92.1 | 84.8 | 77.4 | ...... | ...... |
| 164.9 | 156.8 | 148.8 | 140.7 | 132.7 | 124.6 | 116.6 | 108.5 | 100.5 | 92.4 | 84.4 | ...... | ...... |
| 179.0 | 170.2 | 161.5 | 152.7 | 143.9 | 135.1 | 126.3 | 117.5 | 108.8 | 100.0 | 91.2 | ...... | ...... |
| 193.1 | 183.6 | 174.1 | 164.6 | 155.0 | 145.5 | 136.0 | 126.5 | 117.0 | 107.4 | 97.9 | ...... | ...... |
| 207.5 | 197.2 | 187.0 | 176.8 | 166.6 | 156.3 | 146.1 | 135.9 | 125.7 | 115.4 | 105.2 | ...... | ...... |
| 221.5 | 210.5 | 199.6 | 188.6 | 177.6 | 166.7 | 155.7 | 144.7 | 133.8 | 122.8 | 111.8 | ...... | ...... |
| 235.8 | 224.2 | 212.5 | 200.8 | 189.1 | 177.4 | 165.8 | 154.1 | 142.4 | 130.7 | 119.0 | ...... | ...... |
| 108.5 | 102.9 | 97.4 | 91.8 | 86.3 | 80.7 | 75.2 | 69.6 | 64.0 | 58.5 | 52.9 | ...... | ...... |
| 194.7 | 184.9 | 175.1 | 165.4 | 155.6 | 145.8 | 136.0 | 126.2 | 116.5 | 106.7 | 96.9 | ...... | ...... |
| 209.0 | 198.5 | 188.0 | 177.5 | 167.0 | 156.5 | 146.0 | 135.5 | 125.0 | 114.5 | 104.0 | ...... | ...... |
| 223.2 | 212.0 | 200.8 | 189.6 | 178.4 | 167.2 | 155.9 | 144.7 | 133.5 | 122.3 | 111.1 | ...... | ...... |
| 237.5 | 225.6 | 213.6 | 201.7 | 189.8 | 177.8 | 165.9 | 154.0 | 142.0 | 130.1 | 118.2 | ...... | ...... |
| 251.4 | 238.7 | 226.0 | 213.4 | 200.7 | 188.0 | 175.3 | 162.6 | 150.0 | 137.2 | 124.5 | ...... | ...... |
| 265.7 | 252.3 | 238.9 | 225.4 | 212.0 | 198.6 | 185.2 | 171.8 | 158.4 | 145.0 | 131.6 | ...... | ...... |
| 279.9 | 265.8 | 251.7 | 237.5 | 223.4 | 209.3 | 195.1 | 181.0 | 166.9 | 152.8 | 138.6 | ...... | ...... |
| 123.8 | 117.2 | 110.7 | 104.1 | 97.5 | 91.0 | 84.4 | 77.8 | 71.3 | 64.7 | ...... | ...... | ...... |
| 210.2 | 199.4 | 188.7 | 177.9 | 167.1 | 156.4 | 145.6 | 134.8 | 124.1 | 113.3 | 102.5 | ...... | ...... |
| 238.6 | 226.3 | 214.1 | 201.9 | 189.7 | 177.5 | 165.3 | 153.0 | 140.8 | 128.6 | 116.4 | ...... | ...... |
| 266.9 | 253.3 | 239.6 | 225.9 | 212.2 | 198.6 | 184.9 | 171.2 | 157.6 | 143.9 | 130.2 | ...... | ...... |
| 295.3 | 280.2 | 265.1 | 249.9 | 234.8 | 219.7 | 204.6 | 189.4 | 174.3 | 159.2 | 144.1 | ...... | ...... |
| 139.4 | 131.8 | 124.2 | 116.6 | 109.0 | 101.5 | 93.9 | 86.3 | 78.7 | 71.1 | ...... | ...... | ...... |
| 225.4 | 213.5 | 201.7 | 189.9 | 178.0 | 166.2 | 154.4 | 142.5 | 130.7 | 118.9 | ...... | ...... | ...... |
| 253.5 | 240.2 | 226.9 | 213.6 | 200.3 | 187.0 | 173.7 | 160.4 | 147.0 | 133.7 | ...... | ...... | ...... |
| 282.1 | 267.4 | 252.7 | 237.9 | 223.2 | 208.4 | 193.7 | 179.0 | 164.2 | 149.5 | ...... | ...... | ...... |
| 310.3 | 294.1 | 277.9 | 261.7 | 245.5 | 229.3 | 213.1 | 196.9 | 180.6 | 164.4 | ...... | ...... | ...... |
| 339.0 | 321.4 | 303.8 | 286.2 | 268.5 | 250.9 | 233.3 | 215.7 | 198.1 | 180.4 | ...... | ...... | ...... |

# Columns

## Continued

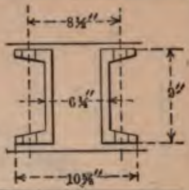
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\,\frac{1}{r}$ for lengths between 30 radii and 150 radii.

| Size of Channels | Size of Plates | Area, Square Inches | Weight per Linear Foot, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 8 | 9 | 10 | 12 | 14 |
| 2-9″—13¼ lbs. | Lattice | 7.78 | 34.3 | 3.49 | ...... | 107.6 | 105.8 | 102.0 | 98.3 |
| | 2-11x¼ | 13.28 | 45.2 | 3.41 | ...... | 183.0 | 179.7 | 173.2 | 166.7 |
| | 2-11x$\frac{5}{16}$ | 14.66 | 49.9 | 3.39 | ...... | 201.9 | 198.2 | 191.0 | 183.7 |
| | 2-11x⅜ | 16.03 | 54.6 | 3.37 | ...... | 220.5 | 216.5 | 208.5 | 200.5 |
| | 2-11x$\frac{7}{16}$ | 17.41 | 59.2 | 3.35 | ...... | 239.3 | 234.9 | 226.2 | 217.4 |
| | 2-11x½ | 18.78 | 63.9 | 3.34 | ...... | 258.0 | 253.3 | 243.8 | 234.4 |
| | 2-11x$\frac{9}{16}$ | 20.16 | 68.6 | 3.33 | ...... | 276.8 | 271.7 | 261.5 | 251.4 |
| | 2-11x⅝ | 21.53 | 73.3 | 3.32 | ...... | 295.5 | 290.0 | 279.1 | 268.2 |
| 2-9″—15 lbs. | Lattice | 8.82 | 37.8 | 3.40 | ...... | 121.5 | 119.3 | 115.0 | 110.6 |
| | 2-11x¼ | 14.32 | 48.7 | 3.37 | ...... | 197.0 | 193.4 | 186.3 | 179.2 |
| | 2-11x$\frac{5}{16}$ | 15.70 | 53.4 | 3.36 | ...... | 215.9 | 212.0 | 204.1 | 196.3 |
| | 2-11x⅜ | 17.07 | 58.1 | 3.34 | ...... | 234.5 | 230.2 | 221.6 | 213.0 |
| | 2-11x$\frac{7}{16}$ | 18.45 | 62.7 | 3.33 | ...... | 253.3 | 248.7 | 239.4 | 230.0 |
| | 2-11x½ | 19.82 | 67.4 | 3.32 | ...... | 272.0 | 267.0 | 256.9 | 246.9 |
| | 2-11x$\frac{9}{16}$ | 21.20 | 72.1 | 3.31 | ...... | 290.8 | 285.4 | 274.7 | 263.9 |
| | 2-11x⅝ | 22.57 | 76.8 | 3.30 | ...... | 309.4 | 303.7 | 292.2 | 280.7 |
| 2-9″—20 lbs. | Lattice | 11.76 | 47.8 | 3.21 | ...... | 160.5 | 157.4 | 151.2 | 145.1 |
| | 2-11x$\frac{5}{16}$ | 18.64 | 63.4 | 3.27 | ...... | 255.2 | 250.4 | 240.8 | 231.2 |
| | 2-11x⅜ | 20.01 | 68.1 | 3.26 | ...... | 273.8 | 268.6 | 258.3 | 248.0 |
| | 2-11x$\frac{7}{16}$ | 21.39 | 72.7 | 3.26 | ...... | 292.6 | 287.1 | 276.1 | 265.1 |
| | 2-11x½ | 22.76 | 77.4 | 3.25 | ...... | 311.2 | 305.3 | 293.6 | 281.8 |
| | 2-11x$\frac{9}{16}$ | 24.14 | 82.1 | 3.25 | ...... | 330.1 | 323.8 | 311.4 | 298.9 |
| | 2-11x⅝ | 25.51 | 86.8 | 3.24 | ...... | 348.6 | 342.0 | 328.8 | 315.6 |
| | 2-11x$\frac{11}{16}$ | 26.89 | 91.4 | 3.24 | ...... | 367.5 | 360.5 | 346.6 | 332.6 |
| | 2-11x¾ | 28.26 | 96.1 | 3.24 | ...... | 386.2 | 378.9 | 364.2 | 349.6 |
| 2-9″—25 lbs. | Lattice | 14.70 | 57.8 | 3.10 | 203.3 | 199.4 | 195.4 | 187.4 | 179.4 |
| | 2-11x⅜ | 22.95 | 78.1 | 3.18 | 318.7 | 312.6 | 306.6 | 294.5 | 282.3 |
| | 2-11x$\frac{7}{16}$ | 24.33 | 82.7 | 3.18 | 337.9 | 331.4 | 325.0 | 312.2 | 299.3 |
| | 2-11x½ | 25.70 | 87.4 | 3.18 | 356.9 | 350.1 | 343.3 | 329.7 | 316.2 |
| | 2-11x$\frac{9}{16}$ | 27.08 | 92.1 | 3.18 | 376.1 | 368.9 | 361.7 | 347.4 | 333.1 |
| | 2-11x⅝ | 28.45 | 96.8 | 3.18 | 395.1 | 387.6 | 380.1 | 365.0 | 350.0 |
| | 2-11x$\frac{11}{16}$ | 29.83 | 101.4 | 3.18 | 414.2 | 406.4 | 398.5 | 382.7 | 367.0 |
| | 2-11x¾ | 31.20 | 106.1 | 3.18 | 433.3 | 425.0 | 416.8 | 400.3 | 383.8 |
| | 2-11x$\frac{13}{16}$ | 32.58 | 110.8 | 3.18 | 452.4 | 443.8 | 435.2 | 418.0 | 400.8 |
| | 2-11x⅞ | 33.95 | 115.5 | 3.18 | 471.5 | 462.5 | 453.5 | 435.6 | 417.6 |
| | 2-11x$\frac{15}{16}$ | 35.33 | 120.1 | 3.18 | 490.6 | 481.3 | 472.0 | 453.3 | 434.6 |

This table continued on next page.

## Safe Loads in Thousands of Pounds
## For 9″ Channel Columns, Square Ends

Section 2-9″ Channels laced with 2″x$\frac{5}{16}$″ Bars or 2-9″ Channels and 2-11″ Plates. Holes $\frac{13}{16}$″; Rivets ¾″ diameter. Column weights do not include Rivets.



LENGTH IN FEET

| 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94.5 | 90.8 | 87.0 | 83.3 | 79.5 | 75.8 | 72.1 | 68.3 | 64.6 | 60.8 | 57.1 | 53.3 | 49.6 |
| 160.1 | 153.6 | 147.0 | 140.5 | 134.0 | 127.4 | 120.9 | 114.3 | 107.8 | 101.3 | 94.7 | 88.2 | 81.6 |
| 176.4 | 169.2 | 161.9 | 154.6 | 147.4 | 140.1 | 132.8 | 125.6 | 118.3 | 111.1 | 103.8 | 96.5 | 89.3 |
| 192.6 | 184.6 | 176.6 | 168.6 | 160.6 | 152.6 | 144.6 | 136.6 | 128.6 | 120.6 | 112.6 | 104.7 | 96.7 |
| 208.7 | 200.0 | 191.3 | 182.5 | 173.8 | 165.1 | 156.3 | 147.6 | 138.9 | 130.1 | 121.4 | 112.7 | 103.9 |
| 224.9 | 215.5 | 206.0 | 196.6 | 187.1 | 177.7 | 168.2 | 158.8 | 149.3 | 139.9 | 130.5 | 121.0 | 111.6 |
| 241.2 | 231.0 | 220.9 | 210.7 | 200.5 | 190.3 | 180.2 | 170.0 | 159.8 | 149.7 | 139.5 | 129.3 | 119.1 |
| 257.3 | 246.4 | 235.5 | 224.6 | 213.7 | 202.9 | 192.0 | 181.1 | 170.2 | 159.3 | 148.4 | 137.5 | 126.6 |
| 106.3 | 101.9 | 97.5 | 93.2 | 88.8 | 84.5 | 80.1 | 75.8 | 71.4 | 67.0 | 62.7 | 58.3 | 54.0 |
| 172.0 | 164.9 | 157.7 | 150.6 | 143.5 | 136.3 | 129.2 | 122.0 | 114.9 | 107.8 | 100.6 | 93.5 | 86.3 |
| 188.4 | 180.6 | 172.7 | 164.9 | 157.0 | 149.2 | 141.3 | 133.5 | 125.6 | 117.8 | 109.9 | 102.1 | 94.2 |
| 204.4 | 195.9 | 187.3 | 178.7 | 170.1 | 161.5 | 152.9 | 144.3 | 135.7 | 127.2 | 118.6 | 110.0 | 101.4 |
| 220.8 | 211.4 | 202.1 | 192.8 | 183.5 | 174.2 | 164.9 | 155.6 | 146.3 | 137.0 | 127.7 | 118.4 | 109.0 |
| 236.9 | 226.9 | 216.8 | 206.8 | 196.8 | 186.7 | 176.7 | 166.7 | 156.7 | 146.6 | 136.6 | 126.6 | 116.5 |
| 253.1 | 242.4 | 231.6 | 220.8 | 210.1 | 199.3 | 188.6 | 177.8 | 167.0 | 156.3 | 145.5 | 134.8 | 124.0 |
| 269.2 | 257.7 | 246.2 | 234.7 | 223.2 | 211.8 | 200.3 | 188.8 | 177.3 | 165.8 | 154.3 | 142.8 | 131.3 |
| 138.9 | 132.8 | 126.6 | 120.5 | 114.3 | 108.2 | 102.0 | 95.8 | 89.7 | 83.5 | 77.4 | 71.2 | 65.1 |
| 221.6 | 212.1 | 202.5 | 192.9 | 183.3 | 173.8 | 164.2 | 154.6 | 145.0 | 135.5 | 125.9 | 116.3 | 106.7 |
| 237.7 | 227.4 | 217.1 | 206.7 | 196.4 | 186.1 | 175.8 | 165.5 | 155.2 | 144.9 | 134.6 | 124.2 | 113.9 |
| 254.1 | 243.0 | 232.0 | 221.0 | 210.0 | 199.0 | 187.9 | 176.9 | 165.9 | 154.9 | 143.8 | 132.8 | 121.8 |
| 270.0 | 258.3 | 246.5 | 234.7 | 223.0 | 211.2 | 199.5 | 187.7 | 175.9 | 164.2 | 152.4 | 140.6 | 128.9 |
| 286.4 | 273.9 | 261.5 | 249.0 | 236.5 | 224.0 | 211.5 | 199.1 | 186.6 | 174.1 | 161.6 | 149.2 | 136.7 |
| 302.3 | 289.1 | 275.9 | 262.7 | 249.4 | 236.2 | 223.0 | 209.8 | 196.5 | 183.3 | 170.1 | 156.9 | 143.6 |
| 318.7 | 304.8 | 290.8 | 276.9 | 262.9 | 249.0 | 235.0 | 221.1 | 207.2 | 193.2 | 179.3 | 165.3 | 151.4 |
| 334.9 | 320.3 | 305.6 | 291.0 | 276.3 | 261.7 | 247.0 | 232.4 | 217.7 | 203.1 | 188.4 | 173.8 | 159.1 |
| 171.5 | 163.5 | 155.5 | 147.6 | 139.6 | 131.6 | 123.7 | 115.7 | 107.7 | 99.8 | 91.8 | 83.8 | ...... |
| 270.2 | 258.1 | 246.0 | 233.8 | 221.7 | 209.6 | 197.5 | 185.3 | 173.2 | 161.1 | 149.0 | 136.8 | ...... |
| 286.4 | 273.6 | 260.7 | 247.9 | 235.0 | 222.2 | 209.3 | 196.5 | 183.6 | 170.8 | 157.9 | 145.1 | ...... |
| 302.6 | 289.0 | 275.4 | 261.8 | 248.3 | 234.7 | 221.1 | 207.5 | 194.0 | 180.4 | 166.8 | 153.2 | ...... |
| 318.8 | 304.5 | 290.2 | 275.9 | 261.6 | 247.3 | 233.0 | 218.7 | 204.4 | 190.1 | 175.8 | 161.4 | ...... |
| 335.0 | 319.9 | 304.9 | 289.9 | 274.8 | 259.8 | 244.8 | 229.7 | 214.7 | 199.7 | 184.6 | 169.6 | ...... |
| 351.2 | 335.4 | 319.7 | 303.9 | 288.2 | 272.4 | 256.6 | 240.9 | 225.1 | 209.4 | 193.6 | 177.8 | ...... |
| 367.3 | 350.8 | 334.4 | 317.9 | 301.4 | 284.9 | 268.4 | 251.9 | 235.5 | 219.0 | 202.5 | 186.0 | ...... |
| 383.6 | 366.4 | 349.2 | 331.9 | 314.7 | 297.5 | 280.3 | 263.1 | 245.9 | 228.7 | 211.5 | 194.2 | ...... |
| 399.7 | 381.8 | 363.8 | 345.9 | 328.0 | 310.0 | 292.1 | 274.2 | 256.2 | 238.3 | 220.3 | 202.4 | ...... |
| 416.0 | 397.3 | 378.6 | 360.0 | 341.3 | 322.6 | 304.0 | 285.3 | 266.6 | 248.0 | 229.3 | 210.6 | ...... |

# Columns

### Continued

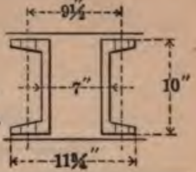
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Size of Channels | Size of Plates | Area, Square Inches | Weight per Linear Foot, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 9 | 10 | 12 | 14 | 16 |
| 2-10″—15 lbs. | Lattice | 8.92 | 37.8 | 3.87 | ...... | 123.4 | 119.5 | 115.6 | 111.7 |
| | 2-12x¼ | 14.92 | 50.4 | 3.77 | ...... | 205.5 | 198.8 | 192.2 | 185.5 |
| | 2-12x5/16 | 16.42 | 55.5 | 3.74 | ...... | 225.8 | 218.5 | 211.1 | 203.7 |
| | 2-12x⅜ | 17.92 | 60.6 | 3.72 | ...... | 246.3 | 238.2 | 230.1 | 222.0 |
| | 2-12x7/16 | 19.42 | 65.7 | 3.70 | ...... | 266.6 | 257.8 | 249.0 | 240.2 |
| | 2-12x½ | 20.92 | 70.8 | 3.68 | ...... | 287.0 | 277.4 | 267.9 | 258.3 |
| | 2-12x9/16 | 22.42 | 75.9 | 3.67 | ...... | 307.4 | 297.2 | 286.9 | 276.6 |
| | 2-12x⅝ | 23.92 | 81.0 | 3.66 | ...... | 327.8 | 316.9 | 305.9 | 294.9 |
| 2-10″—20 lbs. | Lattice | 11.76 | 47.8 | 3.66 | ...... | 161.2 | 155.8 | 150.4 | 145.0 |
| | 2-12x⅜ | 20.76 | 60.6 | 3.65 | ...... | 284.4 | 274.8 | 265.3 | 255.7 |
| | 2-12x7/16 | 22.26 | 75.7 | 3.64 | ...... | 304.8 | 294.5 | 284.2 | 274.0 |
| | 2-12x½ | 23.76 | 80.8 | 3.63 | ...... | 325.2 | 314.2 | 303.2 | 292.2 |
| | 2-12x9/16 | 25.26 | 85.9 | 3.62 | ...... | 345.6 | 333.8 | 322.1 | 310.4 |
| | 2-12x⅝ | 26.76 | 91.0 | 3.61 | ...... | 365.9 | 353.4 | 341.0 | 328.5 |
| | 2-12x11/16 | 28.26 | 96.1 | 3.60 | ...... | 386.2 | 373.0 | 359.9 | 346.7 |
| | 2-12x¾ | 29.76 | 101.2 | 3.60 | ...... | 406.7 | 392.8 | 379.0 | 365.1 |
| 2-10″—25 lbs. | Lattice | 14.70 | 57.8 | 3.52 | 203.6 | 200.1 | 193.1 | 186.1 | 179.1 |
| | 2-12x½ | 26.70 | 90.8 | 3.57 | 370.7 | 364.4 | 351.8 | 339.2 | 326.7 |
| | 2-12x9/16 | 28.20 | 95.9 | 3.57 | 391.5 | 384.8 | 371.6 | 358.3 | 345.0 |
| | 2-12x⅝ | 29.70 | 101.0 | 3.56 | 412.1 | 405.1 | 391.1 | 377.1 | 363.1 |
| | 2-12x11/16 | 31.20 | 106.1 | 3.56 | 433.0 | 425.6 | 410.9 | 396.2 | 381.4 |
| | 2-12x¾ | 32.70 | 111.2 | 3.55 | 453.6 | 445.8 | 430.4 | 414.9 | 399.4 |
| | 2-12x13/16 | 34.20 | 116.3 | 3.55 | 474.4 | 466.3 | 450.1 | 434.0 | 417.7 |
| | 2-12x⅞ | 35.70 | 121.4 | 3.54 | 494.9 | 486.5 | 469.5 | 452.6 | 435.7 |
| 2-10″—30 lbs. | Lattice | 17.64 | 67.8 | 3.42 | 243.2 | 238.9 | 230.2 | 221.6 | 212.9 |
| | 2-12x⅝ | 32.64 | 111.0 | 3.50 | 451.7 | 443.9 | 428.2 | 412.6 | 396.9 |
| | 2-12x¾ | 35.64 | 121.2 | 3.50 | 493.3 | 484.7 | 467.6 | 450.5 | 433.4 |
| | 2-12x⅞ | 38.64 | 131.4 | 3.50 | 534.8 | 525.5 | 507.0 | 488.4 | 469.9 |
| | 2-12x1 | 41.64 | 141.6 | 3.49 | 576.0 | 566.0 | 546.0 | 525.9 | 505.9 |
| 2-10″—35 lbs. | Lattice | 20.58 | 77.8 | 3.35 | 282.8 | 277.7 | 267.4 | 257.0 | 246.7 |
| | 2-12x⅝ | 35.58 | 121.0 | 3.45 | 491.3 | 482.6 | 465.3 | 448.0 | 430.7 |
| | 2-12x¾ | 38.58 | 131.2 | 3.45 | 532.7 | 523.3 | 504.6 | 485.8 | 467.0 |
| | 2-12x⅞ | 41.58 | 141.4 | 3.45 | 574.2 | 564.0 | 543.8 | 523.6 | 503.3 |
| | 2-12x1 | 44.58 | 151.6 | 3.45 | 615.6 | 604.7 | 583.0 | 561.3 | 539.6 |
| | 2-12x1⅛ | 47.58 | 161.8 | 3.45 | 657.0 | 645.4 | 622.3 | 599.1 | 575.9 |

This table continued on next page.

## Safe Loads in Thousands of Pounds
## For 10″ Channel Columns, Square Ends

Section 2–10″ Channels laced with 2″x 5/16″ Bars or 2–10″ Channels and 2–12″ Plates. Holes 13/16″; Rivets 3/4″ diameter. Column weights do not include Rivets.




LENGTH IN FEET

| 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 107.9 | 104.0 | 100.1 | 96.3 | 92.4 | 88.5 | 84.6 | 80.8 | 76.9 | 73.0 | 69.1 | 65.3 | ...... |
| 178.9 | 172.2 | 165.6 | 158.9 | 152.3 | 145.6 | 139.0 | 132.3 | 125.7 | 119.0 | 112.4 | 105.7 | ...... |
| 196.3 | 189.0 | 181.6 | 174.2 | 166.8 | 159.5 | 152.1 | 144.7 | 137.3 | 130.0 | 122.6 | 115.2 | ...... |
| 213.9 | 205.8 | 197.7 | 189.6 | 181.5 | 173.4 | 165.3 | 157.2 | 149.1 | 141.1 | 133.0 | 124.9 | ...... |
| 231.4 | 222.5 | 213.7 | 204.9 | 196.1 | 187.3 | 178.5 | 169.6 | 160.8 | 152.0 | 143.2 | 134.4 | ...... |
| 248.8 | 239.2 | 229.7 | 220.1 | 210.6 | 201.0 | 191.5 | 181.9 | 172.4 | 162.8 | 153.3 | 143.7 | ...... |
| 266.4 | 256.1 | 245.8 | 235.6 | 225.3 | 215.0 | 204.8 | 194.5 | 184.3 | 174.0 | 163.7 | 153.5 | ...... |
| 283.9 | 272.9 | 262.0 | 251.0 | 240.0 | 229.0 | 218.0 | 207.1 | 196.1 | 185.1 | 174.1 | 163.1 | ...... |
| | | | | | | | | | | | | |
| 139.6 | 134.2 | 128.8 | 123.4 | 118.0 | 112.6 | 107.2 | 101.8 | 96.4 | 91.0 | 85.6 | 80.2 | ...... |
| 246.2 | 236.6 | 227.1 | 217.5 | 207.9 | 198.4 | 188.8 | 179.3 | 169.7 | 160.2 | 150.6 | 141.1 | ...... |
| 263.7 | 253.4 | 243.1 | 232.9 | 222.6 | 212.3 | 202.1 | 191.8 | 181.5 | 171.2 | 161.0 | 150.7 | ...... |
| 281.2 | 270.2 | 259.2 | 248.2 | 237.2 | 226.2 | 215.2 | 204.2 | 193.2 | 182.2 | 171.2 | 160.2 | ...... |
| 298.7 | 286.9 | 275.2 | 263.5 | 251.8 | 240.0 | 228.3 | 216.6 | 204.9 | 193.2 | 181.4 | 169.7 | ...... |
| 316.1 | 303.6 | 291.2 | 278.7 | 266.3 | 253.8 | 241.4 | 228.9 | 216.5 | 204.0 | 191.6 | 179.1 | ...... |
| 333.5 | 320.3 | 307.1 | 293.9 | 280.7 | 267.5 | 254.3 | 241.2 | 228.0 | 214.8 | 201.6 | 188.4 | ...... |
| 351.2 | 337.3 | 323.4 | 309.5 | 295.6 | 281.7 | 267.8 | 254.0 | 240.1 | 226.2 | 212.3 | 198.4 | ...... |
| | | | | | | | | | | | | |
| 172.1 | 165.0 | 158.0 | 151.0 | 144.0 | 137.0 | 130.0 | 122.9 | 115.9 | 108.9 | 101.9 | 94.9 | ...... |
| 314.1 | 301.6 | 289.0 | 276.4 | 263.9 | 251.3 | 238.7 | 226.2 | 213.6 | 201.0 | 188.5 | 175.9 | ...... |
| 331.8 | 318.5 | 305.2 | 292.0 | 278.7 | 265.4 | 252.1 | 238.9 | 225.6 | 212.3 | 199.1 | 185.8 | ...... |
| 349.1 | 335.1 | 321.1 | 307.0 | 293.0 | 279.0 | 265.0 | 251.0 | 237.0 | 223.0 | 209.0 | 194.9 | ...... |
| 366.7 | 352.0 | 337.3 | 322.6 | 307.8 | 293.1 | 278.4 | 263.7 | 249.0 | 234.2 | 219.5 | 204.8 | ...... |
| 383.9 | 368.5 | 353.0 | 337.5 | 322.0 | 306.6 | 291.1 | 275.6 | 260.1 | 244.7 | 229.2 | 213.7 | ...... |
| 401.5 | 385.4 | 369.2 | 353.0 | 336.8 | 320.6 | 304.4 | 288.3 | 272.1 | 255.9 | 239.7 | 223.5 | ...... |
| 418.7 | 401.8 | 384.8 | 367.9 | 350.9 | 334.0 | 317.1 | 300.1 | 283.2 | 266.2 | 249.3 | 232.3 | ...... |
| | | | | | | | | | | | | |
| 204.2 | 195.6 | 186.9 | 178.2 | 169.6 | 160.9 | 152.2 | 143.5 | 134.9 | 126.2 | 117.5 | 108.9 | ...... |
| 381.2 | 365.6 | 349.9 | 334.2 | 318.6 | 302.9 | 287.2 | 271.6 | 255.9 | 240.2 | 224.6 | 208.9 | ...... |
| 416.3 | 399.2 | 382.1 | 365.0 | 347.8 | 330.7 | 313.6 | 296.5 | 279.4 | 262.3 | 245.2 | 228.1 | ...... |
| 451.3 | 432.8 | 414.2 | 395.7 | 377.1 | 358.6 | 340.0 | 321.5 | 302.9 | 284.4 | 265.8 | 247.3 | ...... |
| 485.8 | 465.8 | 445.7 | 425.7 | 405.7 | 385.6 | 365.6 | 345.5 | 325.5 | 305.4 | 285.4 | 265.4 | ...... |
| | | | | | | | | | | | | |
| 236.4 | 226.1 | 215.8 | 205.4 | 195.1 | 184.8 | 174.5 | 164.1 | 153.8 | 143.5 | 133.2 | 122.9 | ...... |
| 413.3 | 396.0 | 378.7 | 361.4 | 344.0 | 326.7 | 309.4 | 292.1 | 274.7 | 257.4 | 240.1 | 222.8 | ...... |
| 448.2 | 429.4 | 410.6 | 391.8 | 373.1 | 354.3 | 335.5 | 316.7 | 297.9 | 279.1 | 260.3 | 241.5 | ...... |
| 483.1 | 462.8 | 442.6 | 422.3 | 402.1 | 381.8 | 361.6 | 341.3 | 321.1 | 300.8 | 280.6 | 260.3 | ...... |
| 517.9 | 496.2 | 474.5 | 452.8 | 431.0 | 409.4 | 387.7 | 365.9 | 344.2 | 322.5 | 300.8 | 279.1 | ...... |
| 552.8 | 529.6 | 506.4 | 483.2 | 460.1 | 436.9 | 413.8 | 390.6 | 367.4 | 344.2 | 321.1 | 297.9 | ...... |

# Columns

## Continued

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\,\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Size of Channels | Size of Plates | Area, Square Inches | Weight per Linear Foot, Pounds | Least Radius of Gyration, Inches | Length in Feet 12 | 14 | 16 | 18 |
|---|---|---|---|---|---|---|---|---|
| 2-12″—20½ lbs. | Lattice | 12.06 | 48.8 | 4.61 | 166.6 | 162.2 | 157.8 | 153.4 |
| | 2-14x5/16 | 20.81 | 70.8 | 4.39 | 285.2 | 277.2 | 269.3 | 261.3 |
| | 2-14x⅜ | 22.56 | 76.7 | 4.36 | 308.8 | 300.1 | 291.4 | 282.7 |
| | 2-14x7/16 | 24.31 | 82.7 | 4.34 | 332.5 | 323.1 | 313.7 | 304.3 |
| | 2-14x½ | 26.06 | 88.6 | 4.32 | 356.2 | 346.0 | 335.9 | 325.8 |
| | 2-14x9/16 | 27.81 | 94.6 | 4.30 | 379.8 | 368.9 | 358.0 | 347.2 |
| | 2-14x⅝ | 29.56 | 100.5 | 4.29 | 403.5 | 391.9 | 380.4 | 368.8 |
| | 2-14x11/16 | 31.31 | 106.5 | 4.28 | 427.2 | 414.9 | 402.6 | 390.3 |
| | 2-14x¾ | 33.06 | 112.4 | 4.26 | 450.7 | 437.7 | 424.7 | 411.6 |
| 2-12″—25 lbs. | Lattice | 14.70 | 57.8 | 4.43 | 201.8 | 196.2 | 190.6 | 185.0 |
| | 2-14x⅜ | 25.20 | 85.7 | 4.30 | 344.1 | 334.3 | 324.4 | 314.6 |
| | 2-14x7/16 | 26.95 | 91.7 | 4.29 | 367.9 | 357.3 | 346.8 | 336.2 |
| | 2-14x½ | 28.70 | 97.6 | 4.27 | 391.5 | 380.2 | 368.9 | 357.6 |
| | 2-14x9/16 | 30.45 | 103.6 | 4.26 | 415.2 | 403.1 | 391.1 | 379.1 |
| | 2-14x⅝ | 32.20 | 109.5 | 4.25 | 438.8 | 426.1 | 413.4 | 400.6 |
| | 2-14x11/16 | 33.95 | 115.5 | 4.24 | 462.5 | 449.0 | 435.6 | 422.1 |
| | 2-14x¾ | 35.70 | 121.4 | 4.23 | 486.1 | 471.9 | 457.8 | 443.6 |
| | 2-14x13/16 | 37.45 | 127.4 | 4.22 | 509.7 | 494.8 | 479.9 | 465.0 |
| | 2-14x⅞ | 39.20 | 133.3 | 4.21 | 533.3 | 517.7 | 502.1 | 486.4 |
| 2-12″—30 lbs. | Lattice | 17.64 | 67.8 | 4.28 | 240.7 | 233.8 | 226.8 | 219.9 |
| | 2-14x½ | 31.64 | 107.6 | 4.22 | 430.7 | 418.1 | 405.5 | 392.9 |
| | 2-14x⅝ | 35.14 | 119.5 | 4.20 | 477.9 | 463.8 | 449.8 | 435.7 |
| | 2-14x¾ | 38.64 | 131.4 | 4.19 | 525.3 | 509.8 | 494.3 | 478.8 |
| | 2-14x⅞ | 42.14 | 143.3 | 4.18 | 572.6 | 555.7 | 538.7 | 521.8 |
| | 2-14x1 | 45.64 | 155.2 | 4.17 | 619.9 | 601.5 | 583.2 | 564.8 |
| 2-12″—35 lbs. | Lattice | 20.58 | 77.8 | 4.17 | 279.5 | 271.2 | 263.0 | 254.7 |
| | 2-14x⅝ | 38.08 | 129.5 | 4.16 | 517.0 | 501.6 | 486.3 | 470.9 |
| | 2-14x¾ | 41.58 | 141.4 | 4.15 | 564.3 | 547.5 | 530.6 | 513.8 |
| | 2-14x⅞ | 45.08 | 153.3 | 4.14 | 611.5 | 593.2 | 574.9 | 556.6 |
| | 2-14x1 | 48.58 | 165.2 | 4.13 | 658.7 | 639.0 | 619.2 | 599.4 |
| 2-12″—40 lbs. | Lattice | 23.52 | 87.8 | 4.09 | 318.4 | 308.7 | 299.0 | 289.4 |
| | 2-14x¾ | 44.52 | 151.4 | 4.10 | 602.9 | 584.6 | 566.4 | 548.1 |
| | 2-14x⅞ | 48.02 | 163.3 | 4.10 | 650.3 | 630.6 | 610.9 | 591.2 |
| | 2-14x1 | 51.52 | 175.2 | 4.10 | 697.7 | 676.5 | 655.4 | 634.3 |
| | 2-14x1⅛ | 55.02 | 187.1 | 4.09 | 744.7 | 722.1 | 699.5 | 676.9 |
| | 2-14x1¼ | 58.52 | 199.0 | 4.09 | 792.1 | 768.1 | 744.0 | 720.0 |

This table continued on next page.

# Columns

## Continued

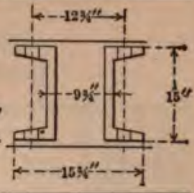
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Size of Channels | Size of Plates | Area, Square Inches | Weight per Linear Foot, Pounds | Least Radius of Gyration, Inches | Length in Feet | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 12 | 14 | 16 | 18 |
| 2-15″—33 lbs. | Lattice | 19.80 | 76.0 | 5.35 | ...... | 273.3 | 267.1 | 260.9 |
| | 2-16x⅜ | 31.80 | 106.8 | 5.08 | ...... | 435.2 | 424.7 | 414.1 |
| | 2-16x7/16 | 33.80 | 113.6 | 5.06 | ...... | 462.3 | 451.0 | 439.8 |
| | 2-16x½ | 35.80 | 120.4 | 5.03 | ...... | 489.1 | 477.1 | 465.2 |
| | 2-16x9/16 | 37.80 | 127.2 | 5.01 | ...... | 516.1 | 503.4 | 490.7 |
| | 2-16x⅝ | 39.80 | 134.0 | 4.99 | ...... | 543.1 | 529.6 | 516.2 |
| | 2-16x11/16 | 41.80 | 140.8 | 4.98 | ...... | 570.0 | 556.0 | 541.9 |
| | 2-16x¾ | 43.80 | 147.6 | 4.96 | ...... | 597.0 | 582.1 | 567.3 |
| | 2-16x13/16 | 45.80 | 154.4 | 4.95 | ...... | 624.0 | 608.5 | 592.9 |
| | 2-16x⅞ | 47.80 | 161.2 | 4.93 | ...... | 650.8 | 634.5 | 618.2 |
| | 2-16x1 | 51.80 | 174.8 | 4.91 | ...... | 704.7 | 687.0 | 669.3 |
| 2-15″—35 lbs. | Lattice | 20.58 | 80.0 | 5.32 | ...... | 283.8 | 277.3 | 270.8 |
| | 2-16x⅜ | 32.58 | 110.8 | 5.07 | ...... | 445.8 | 434.9 | 424.1 |
| | 2-16x½ | 36.58 | 124.4 | 5.02 | ...... | 499.6 | 487.3 | 475.1 |
| | 2-16x⅝ | 40.58 | 138.0 | 4.98 | ...... | 553.4 | 539.8 | 526.1 |
| | 2-16x¾ | 44.58 | 151.6 | 4.95 | ...... | 607.4 | 592.3 | 577.1 |
| | 2-16x⅞ | 48.58 | 165.2 | 4.93 | ...... | 661.4 | 644.8 | 628.2 |
| | 2-16x1 | 52.58 | 178.8 | 4.90 | ...... | 715.1 | 697.2 | 679.0 |
| 2-15″—40 lbs. | Lattice | 23.52 | 90.0 | 5.21 | ...... | 323.3 | 315.6 | 308.1 |
| | 2-16x½ | 39.52 | 134.4 | 4.98 | ...... | 538.9 | 525.7 | 512.4 |
| | 2-16x¾ | 47.52 | 161.6 | 4.92 | ...... | 646.7 | 630.5 | 614.3 |
| | 2-16x1 | 55.52 | 188.8 | 4.88 | ...... | 754.5 | 735.4 | 716.3 |
| | 2-16x1¼ | 63.52 | 216.0 | 4.85 | ...... | 862.3 | 840.3 | 818.3 |
| | 2-16x1½ | 71.52 | 243.2 | 4.82 | ...... | 969.8 | 944.9 | 920.0 |
| 2-15″—45 lbs. | Lattice | 26.48 | 100.0 | 5.12 | ...... | 362.9 | 354.2 | 345.5 |
| | 2-16x½ | 42.48 | 144.4 | 4.94 | ...... | 578.5 | 564.1 | 549.7 |
| | 2-16x¾ | 50.48 | 171.6 | 4.89 | ...... | 686.3 | 668.9 | 651.6 |
| | 2-16x1 | 58.48 | 198.8 | 4.85 | ...... | 793.8 | 773.6 | 753.3 |
| | 2-16x1¼ | 66.48 | 226.0 | 4.82 | ...... | 901.5 | 878.3 | 855.1 |
| | 2-16x1½ | 74.48 | 253.2 | 4.80 | 1035.2 | 1009.2 | 983.1 | 957.1 |
| 2-15″—50 lbs. | Lattice | 29.42 | 110.0 | 5.03 | ...... | 401.9 | 392.1 | 382.3 |
| | 2-16x¾ | 53.42 | 181.6 | 4.85 | ...... | 725.2 | 706.7 | 688.2 |
| | 2-16x1 | 61.42 | 208.8 | 4.82 | ...... | 832.9 | 811.5 | 790.1 |
| | 2-16x1¼ | 69.42 | 236.0 | 4.80 | 965.0 | 940.7 | 916.3 | 892.0 |
| | 2-16x1½ | 77.42 | 263.2 | 4.78 | 1075.5 | 1048.3 | 1021.1 | 993.8 |
| 2-15″—55 lbs. | Lattice | 32.36 | 120.0 | 4.96 | ...... | 441.0 | 430.1 | 419.1 |
| | 2-16x¾ | 56.36 | 191.6 | 4.82 | ...... | 764.2 | 744.6 | 724.9 |
| | 2-16x1 | 64.36 | 218.8 | 4.80 | 894.6 | 872.0 | 849.5 | 827.0 |
| | 2-16x1¼ | 72.36 | 246.0 | 4.78 | 1005.2 | 979.7 | 954.3 | 928.9 |
| | 2-16x1½ | 80.36 | 273.2 | 4.76 | 1115.6 | 1087.3 | 1050.9 | 1030.5 |

*This table* continued on next page.

## Safe Loads in Thousands of Pounds
## For 15″ Channel Columns, Square Ends

Section 2-15″ Channels laced with 2¼″x⅜″ Bars or 2-15″ Channels and 2-16″ Plates. Holes $\frac{13}{16}$″; Rivets ¾″ diameter. Column weights do not include rivets.




Length in Feet

| 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|
| 254.6 | 248.4 | 242.2 | 236.0 | 229.8 | 223.5 | 217.4 | 211.1 | 204.9 | 198.6 | 192.5 |
| 403.6 | 393.1 | 382.6 | 372.0 | 361.6 | 351.0 | 340.5 | 330.0 | 319.5 | 309.0 | 298.5 |
| 428.6 | 417.4 | 406.1 | 394.9 | 383.7 | 372.5 | 361.2 | 350.0 | 338.8 | 327.6 | 316.4 |
| 453.2 | 441.3 | 429.3 | 417.4 | 405.4 | 393.4 | 381.5 | 369.5 | 357.6 | 345.6 | 333.7 |
| 478.0 | 465.4 | 452.7 | 440.0 | 427.3 | 414.7 | 402.0 | 389.3 | 376.6 | 364.0 | 351.3 |
| 502.8 | 489.4 | 476.0 | 462.6 | 449.2 | 435.8 | 422.4 | 409.0 | 395.6 | 382.2 | 368.7 |
| 527.8 | 513.7 | 499.6 | 485.5 | 471.4 | 457.3 | 443.0 | 428.9 | 415.0 | 400.9 | 386.7 |
| 552.4 | 537.6 | 522.8 | 507.9 | 493.1 | 478.3 | 463.4 | 448.6 | 433.8 | 418.9 | 404.1 |
| 577.4 | 561.8 | 546.3 | 530.7 | 515.2 | 499.7 | 484.1 | 468.6 | 453.0 | 437.5 | 421.9 |
| 601.9 | 585.6 | 569.4 | 553.1 | 536.8 | 520.5 | 504.2 | 487.9 | 471.6 | 455.3 | 439.0 |
| 651.6 | 633.8 | 616.1 | 598.4 | 580.7 | 562.9 | 545.2 | 527.5 | 509.8 | 492.1 | 474.3 |
| 264.3 | 257.8 | 251.3 | 244.8 | 238.3 | 231.8 | 225.3 | 218.8 | 212.3 | 205.8 | 199.3 |
| 413.3 | 402.5 | 391.7 | 380.9 | 370.1 | 359.3 | 348.6 | 337.8 | 327.0 | 316.2 | 305.3 |
| 462.9 | 450.6 | 438.4 | 426.1 | 413.9 | 401.7 | 389.4 | 377.1 | 364.9 | 352.7 | 340.4 |
| 512.4 | 498.7 | 485.0 | 471.3 | 457.6 | 443.9 | 430.3 | 416.6 | 402.9 | 389.2 | 375.4 |
| 562.0 | 546.9 | 531.7 | 516.6 | 501.5 | 486.4 | 471.2 | 456.1 | 441.0 | 425.8 | 410.7 |
| 611.7 | 595.1 | 578.6 | 562.0 | 545.5 | 528.9 | 512.4 | 495.8 | 479.3 | 462.7 | 446.2 |
| 661.1 | 643.1 | 625.0 | 607.0 | 588.9 | 570.9 | 552.9 | 534.9 | 516.8 | 498.8 | 480.6 |
| 300.5 | 292.9 | 285.3 | 277.7 | 270.1 | 262.6 | 254.9 | 247.4 | 239.8 | 232.2 | 224.7 |
| 499.0 | 485.7 | 472.3 | 459.0 | 445.7 | 432.3 | 419.0 | 405.7 | 392.3 | 379.0 | 365.6 |
| 598.1 | 581.9 | 565.6 | 549.4 | 533.2 | 517.0 | 500.8 | 484.5 | 468.3 | 452.1 | 435.8 |
| 697.2 | 678.1 | 659.0 | 639.8 | 620.7 | 601.6 | 582.5 | 563.4 | 544.3 | 525.2 | 506.0 |
| 796.3 | 774.3 | 752.3 | 730.3 | 708.3 | 686.3 | 664.3 | 642.3 | 620.3 | 598.3 | 576.3 |
| 895.0 | 870.1 | 845.2 | 820.2 | 795.3 | 770.4 | 745.5 | 720.5 | 695.6 | 670.7 | 645.8 |
| 336.8 | 328.1 | 319.4 | 310.7 | 302.0 | 293.4 | 284.7 | 276.0 | 267.3 | 258.6 | 250.0 |
| 535.2 | 520.8 | 506.3 | 491.9 | 477.4 | 463.0 | 448.5 | 434.1 | 419.6 | 405.2 | 390.7 |
| 634.2 | 616.9 | 599.6 | 582.2 | 564.9 | 547.5 | 530.2 | 512.8 | 495.5 | 478.2 | 460.9 |
| 733.1 | 712.8 | 692.6 | 672.3 | 652.1 | 631.8 | 611.6 | 591.3 | 571.0 | 550.8 | 530.5 |
| 831.9 | 808.8 | 785.6 | 762.4 | 739.3 | 716.1 | 693.0 | 669.8 | 646.6 | 623.4 | 600.3 |
| 931.0 | 904.9 | 878.9 | 852.8 | 826.7 | 800.7 | 774.6 | 748.5 | 722.5 | 696.4 | 670.3 |
| 372.5 | 362.6 | 352.8 | 343.0 | 333.2 | 323.3 | 313.5 | 303.7 | 293.8 | 284.0 | 274.2 |
| 669.7 | 651.2 | 632.7 | 614.1 | 595.6 | 577.1 | 558.6 | 540.1 | 521.6 | 503.1 | 484.6 |
| 768.7 | 747.3 | 725.9 | 704.5 | 683.1 | 661.7 | 640.3 | 618.9 | 597.5 | 576.0 | 554.6 |
| 867.8 | 843.5 | 819.2 | 794.9 | 770.6 | 746.3 | 722.0 | 697.1 | 673.4 | 649.1 | 624.8 |
| 966.6 | 939.4 | 912.2 | 885.0 | 857.8 | 830.6 | 803.3 | 776.1 | 748.9 | 721.7 | 694.5 |
| 408.2 | 397.2 | 386.2 | 375.3 | 364.3 | 353.4 | 342.4 | 331.4 | 320.5 | 309.5 | 298.6 |
| 705.3 | 685.7 | 666.0 | 646.4 | 626.7 | 607.1 | 587.4 | 567.8 | 548.2 | 528.5 | 508.9 |
| 804.5 | 782.0 | 759.4 | 736.9 | 714.4 | 691.9 | 669.3 | 646.8 | 624.3 | 601.8 | 579.2 |
| 903.4 | 878.0 | 852.6 | 827.1 | 801.7 | 776.3 | 750.8 | 725.4 | 700.0 | 674.5 | 649.1 |
| 1002.1 | 973.8 | 945.4 | 917.1 | 888.7 | 860.4 | 832.0 | 803.6 | 775.2 | 746.9 | 718.6 |

# Columns

## Continued

| Outside Diameter, Inches | Thickness of Metal, Inches | Length of Column in Feet | | | | | | | | | Sectional Area, Square Inches | Weight per Foot of Length of Column, Lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | | |
| 6 | ½ | 52.4 | 46.0 | 40.2 | 35.0 | 30.4 | 26.4 | 23.0 | ...... | ...... | 8.6 | 26.95 |
| 6 | ¾ | 75.0 | 66.0 | 57.6 | 50.0 | 43.4 | 37.8 | 33.0 | ...... | ...... | 12.4 | 38.59 |
| 6 | ⅞ | 85.4 | 75.2 | 65.6 | 59.0 | 49.4 | 43.0 | 37.6 | ...... | ...... | 14.1 | 43.96 |
| 6 | 1 | 95.2 | 83.8 | 73.0 | 63.6 | 55.2 | 48.0 | 42.0 | ...... | ...... | 15.7 | 49.01 |
| 6 | 1⅛ | 104.4 | 92.0 | 80.2 | 69.6 | 60.4 | 52.6 | 46.0 | ...... | ...... | 17.2 | 53.76 |
| 7 | ¾ | 95.4 | 86.2 | 77.0 | 68.6 | 60.8 | 53.8 | 47.8 | 42.4 | 37.8 | 14.7 | 45.96 |
| 7 | 1 | 122.2 | 110.4 | 98.6 | 87.6 | 77.8 | 68.8 | 61.2 | 54.2 | 48.4 | 18.9 | 58.90 |
| 7 | 1⅛ | 134.4 | 121.6 | 108.6 | 96.6 | 85.6 | 75.8 | 67.4 | 59.8 | 53.4 | 20.8 | 64.77 |
| 8 | ¾ | 115.8 | 106.6 | 97.2 | 88.2 | 79.4 | 71.6 | 64.4 | 57.8 | 52.2 | 17.1 | 53.29 |
| 8 | 1 | 149.2 | 137.4 | 125.0 | 113.4 | 102.2 | 92.0 | 82.8 | 74.6 | 67.2 | 22.0 | 68.64 |
| 8 | 1¼ | 179.8 | 165.6 | 151.0 | 136.8 | 123.4 | 111.0 | 99.8 | 89.8 | 91.0 | 26.5 | 82.71 |
| 9 | ¾ | 136.2 | 127.2 | 117.8 | 108.4 | 99.2 | 90.4 | 82.4 | 75.0 | 68.2 | 19.4 | 60.65 |
| 9 | 1 | 176.0 | 164.6 | 152.4 | 140.0 | 128.2 | 116.8 | 106.4 | 96.8 | 88.2 | 25.1 | 78.40 |
| 9 | 1¼ | 213.2 | 199.2 | 184.4 | 169.6 | 155.2 | 141.6 | 128.8 | 117.4 | 106.8 | 30.4 | 94.94 |
| 9 | 1½ | 247.6 | 231.4 | 214.2 | 197.0 | 180.2 | 164.4 | 149.6 | 136.2 | 124.0 | 35.3 | 110.26 |
| 9 | 1¾ | 279.2 | 261.0 | 241.6 | 222.2 | 203.2 | 185.4 | 168.8 | 153.6 | 139.8 | 39.9 | 124.36 |
| 10 | 1 | 202.8 | 191.8 | 179.6 | 167.2 | 154.8 | 143.0 | 131.6 | 121.0 | 111.0 | 28.3 | 88.23 |
| 10 | 1¼ | 246.6 | 233.0 | 218.2 | 203.2 | 188.2 | 173.6 | 159.8 | 146.8 | 135.0 | 34.4 | 107.23 |
| 10 | 1½ | 287.4 | 271.6 | 254.6 | 237.0 | 219.4 | 202.4 | 186.4 | 170.0 | 157.4 | 40.1 | 124.99 |
| 10 | 1¾ | 325.4 | 307.6 | 288.2 | 268.2 | 248.4 | 229.2 | 211.0 | 194.0 | 178.2 | 45.4 | 141.65 |
| 11 | 1 | 229.6 | 218.8 | 207.0 | 194.6 | 182.0 | 169.6 | 160.4 | 146.0 | 135.4 | 31.4 | 98.03 |
| 11 | 1¼ | 279.8 | 266.6 | 252.2 | 237.2 | 221.8 | 206.6 | 195.6 | 178.8 | 165.0 | 38.3 | 119.46 |
| 11 | 1½ | 327.0 | 311.8 | 295.0 | 277.2 | 257.4 | 241.6 | 228.6 | 208.2 | 192.8 | 44.8 | 139.68 |
| 11 | 1¾ | 371.4 | 354.2 | 335.0 | 315.0 | 294.6 | 274.4 | 259.6 | 236.6 | 219.0 | 50.9 | 158.68 |
| 11 | 2 | 413.2 | 393.8 | 372.6 | 350.2 | 327.6 | 305.2 | 288.8 | 263.0 | 243.6 | 56.6 | 176.44 |

The above table is based on the Gordon Formula $P = \dfrac{8000}{1 + \dfrac{l^2}{800d^2}}$

in which P = Allowable pressure per square inch of cross section.
l = Length of Column in inches.
d = Outside diameter in inches.

This table continued on next page.

## Safe Loads in Thousands of Pounds
## Hollow Cylindrical Cast Iron Columns

| Outside Diameter, Inches | Thickness of Metal, Inches | Length of Column in Feet | | | | | | | | | Sectional Area, Square Inches | Weight per Foot of Length of Column, Lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | | |
| 12 | 1 | 256.0 | 245.8 | 234.4 | 222.0 | 209.4 | 196.8 | 184.4 | 172.2 | 160.8 | 34.6 | 107.51 |
| 12 | 1¼ | 312.8 | 300.2 | 286.2 | 271.4 | 255.8 | 240.4 | 225.2 | 210.4 | 196.4 | 42.2 | 131.41 |
| 12 | 1½ | 366.6 | 351.8 | 335.4 | 318.0 | 299.8 | 281.8 | 264.0 | 246.6 | 230.2 | 49.5 | 154.10 |
| 12 | 1¾ | 417.4 | 400.8 | 382.0 | 362.2 | 341.4 | 320.8 | 300.6 | 281.0 | 262.2 | 56.4 | 175.53 |
| 12 | 2 | 465.4 | 446.8 | 426.0 | 403.8 | 380.8 | 357.8 | 335.2 | 313.2 | 292.2 | 62.8 | 195.75 |
| 13 | 1 | 282.4 | 272.6 | 261.4 | 249.4 | 237.0 | 224.2 | 211.6 | 199.0 | 187.0 | 37.7 | 117.53 |
| 13 | 1¼ | 345.6 | 333.6 | 320.0 | 305.4 | 290.0 | 274.4 | 258.8 | 243.6 | 228.8 | 46.1 | 143.86 |
| 13 | 1½ | 406.0 | 391.8 | 375.8 | 358.6 | 340.6 | 322.2 | 304.0 | 286.2 | 268.6 | 54.2 | 168.98 |
| 13 | 1¾ | 463.2 | 447.2 | 429.0 | 409.4 | 388.8 | 367.8 | 347.0 | 326.6 | 306.6 | 61.9 | 192.88 |
| 13 | 2 | 517.8 | 499.8 | 479.4 | 457.4 | 434.6 | 411.0 | 387.8 | 365.0 | 342.6 | 69.1 | 215.56 |
| 14 | 1 | 308.6 | 299.2 | 288.6 | 277.0 | 264.6 | 251.8 | 239.0 | 226.2 | 213.6 | 40.8 | 127.60 |
| 14 | 1¼ | 378.4 | 366.8 | 353.8 | 339.4 | 324.4 | 308.8 | 293.0 | 277.2 | 262.0 | 50.1 | 156.31 |
| 14 | 1½ | 445.2 | 431.6 | 416.2 | 399.4 | 381.6 | 363.4 | 344.6 | 326.2 | 308.2 | 58.9 | 183.67 |
| 14 | 1¾ | 508.8 | 493.4 | 475.8 | 456.6 | 436.2 | 415.2 | 394.0 | 373.0 | 352.4 | 67.4 | 210.00 |
| 14 | 2 | 569.6 | 552.4 | 532.8 | 511.2 | 488.4 | 464.8 | 441.2 | 417.6 | 394.4 | 75.4 | 235.12 |
| 15 | 1 | 334.8 | 325.8 | 315.6 | 304.2 | 292.0 | 279.4 | 266.6 | 253.6 | 240.8 | 44.0 | 137.28 |
| 15 | 1¼ | 411.0 | 400.0 | 387.4 | 373.4 | 358.6 | 343.0 | 327.2 | 311.4 | 295.8 | 54.0 | 168.48 |
| 15 | 1½ | 484.2 | 471.4 | 456.4 | 440.0 | 422.4 | 404.2 | 385.6 | 367.0 | 348.4 | 63.6 | 198.74 |
| 15 | 1¾ | 554.4 | 539.6 | 522.6 | 503.8 | 483.8 | 462.8 | 441.4 | 420.2 | 399.0 | 72.9 | 227.45 |
| 15 | 2 | 621.6 | 605.0 | 586.0 | 565.0 | 542.4 | 519.0 | 495.0 | 471.0 | 447.2 | 81.7 | 254.90 |

The above table is based on the Gordon Formula $P = \dfrac{8000}{1 + \dfrac{l^2}{800d^2}}$

in which P = Allowable pressure per square inch of cross section.
l = Length of Column in inches.
d = Outside diameter in inches.

# Struts

## Safe Strength of Steel Struts

For different proportions of length in inches = l
To least radius of gyration in inches = r

Safe strength in pounds per square inch = $16000-70\,\frac{l}{r}$

| $\frac{l}{r}$ | Safe Strength per Square Inch, Pounds | $\frac{l}{r}$ | Safe Strength per Square Inch, Pounds | $\frac{l}{r}$ | Safe Strength per Square Inch, Pounds | $\frac{l}{r}$ | Safe Strength per Square Inch, Pounds |
|---|---|---|---|---|---|---|---|
| 30 | 13900 | 60 | 11800 | 90 | 9700 | 120 | 7600 |
| 31 | 13830 | 61 | 11730 | 91 | 9630 | 121 | 7530 |
| 32 | 13760 | 62 | 11660 | 92 | 9560 | 122 | 7460 |
| 33 | 13690 | 63 | 11590 | 93 | 9490 | 123 | 7390 |
| 34 | 13620 | 64 | 11520 | 94 | 9420 | 124 | 7320 |
| 35 | 13550 | 65 | 11450 | 95 | 9350 | 125 | 7250 |
| 36 | 13480 | 66 | 11380 | 96 | 9280 | 126 | 7180 |
| 37 | 13410 | 67 | 11310 | 97 | 9210 | 127 | 7110 |
| 38 | 13340 | 68 | 11240 | 98 | 9140 | 128 | 7040 |
| 39 | 13270 | 69 | 11170 | 99 | 9070 | 129 | 6970 |
| 40 | 13200 | 70 | 11100 | 100 | 9000 | 130 | 6900 |
| 41 | 13130 | 71 | 11030 | 101 | 8930 | 131 | 6830 |
| 42 | 13060 | 72 | 10960 | 102 | 8860 | 132 | 6760 |
| 43 | 12990 | 73 | 10890 | 103 | 8790 | 133 | 6690 |
| 44 | 12920 | 74 | 10820 | 104 | 8720 | 134 | 6620 |
| 45 | 12850 | 75 | 10750 | 105 | 8650 | 135 | 6550 |
| 46 | 12780 | 76 | 10680 | 106 | 8580 | 136 | 6480 |
| 47 | 12710 | 77 | 10610 | 107 | 8510 | 137 | 6410 |
| 48 | 12640 | 78 | 10540 | 108 | 8440 | 138 | 6340 |
| 49 | 12570 | 79 | 10470 | 109 | 8370 | 139 | 6270 |
| 50 | 12500 | 80 | 10400 | 110 | 8300 | 140 | 6200 |
| 51 | 12430 | 81 | 10330 | 111 | 8230 | 141 | 6130 |
| 52 | 12360 | 82 | 10260 | 112 | 8160 | 142 | 6060 |
| 53 | 12290 | 83 | 10190 | 113 | 8090 | 143 | 5990 |
| 54 | 12220 | 84 | 10120 | 114 | 8020 | 144 | 5920 |
| 55 | 12150 | 85 | 10050 | 115 | 7950 | 145 | 5850 |
| 56 | 12080 | 86 | 9980 | 116 | 7880 | 146 | 5780 |
| 57 | 12010 | 87 | 9910 | 117 | 7810 | 147 | 5710 |
| 58 | 11940 | 88 | 9840 | 118 | 7740 | 148 | 5640 |
| 59 | 11870 | 89 | 9770 | 119 | 7670 | 149 | 5570 |
| | | | | | | 150 | 5500 |

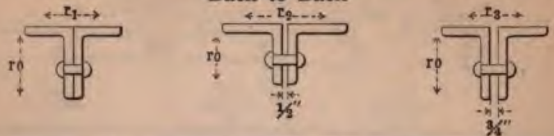
# Radii of Gyration

## For Two Unequal Legged Angles, Placed with Shorter Legs Back to Back


| Size of Angles, Inches | Weight per Foot of Single Angle, Pounds | Area of Two Angles, Square Inches | Radii of Gyration $r_0$ | $r_1$ | $r_2$ | $r_3$ |
|---|---|---|---|---|---|---|
| 8 x 6 x 1⅛ | 49.3 | 29.00 | 1.71 | 3.66 | 3.85 | 3.95 |
| 8 x 6 x ½ | 23.0 | 13.50 | 1.79 | 3.56 | 3.74 | 3.83 |
| 7 x 3½ x ⅞ | 28.7 | 16.84 | 0.90 | 3.45 | 3.65 | 3.75 |
| 7 x 3½ x 7/16 | 15.0 | 8.80 | 0.95 | 3.37 | 3.56 | 3.66 |
| 6 x 4 x 13/16 | 25.4 | 14.94 | 1.11 | 2.81 | 3.00 | 3.10 |
| 6 x 4 x ⅜ | 12.3 | 7.22 | 1.17 | 2.74 | 2.92 | 3.01 |
| 6 x 3½ x ¾ | 22.4 | 13.12 | 0.94 | 2.88 | 3.08 | 3.18 |
| 6 x 3½ x ⅜ | 11.7 | 6.84 | 0.99 | 2.81 | 3.00 | 3.10 |
| 5 x 4 x 13/16 | 22.7 | 13.30 | 1.15 | 2.27 | 2.46 | 2.56 |
| 5 x 4 x ⅜ | 11.0 | 6.46 | 1.20 | 2.20 | 2.38 | 2.48 |
| 5 x 3½ x ¾ | 19.8 | 11.62 | 0.98 | 2.34 | 2.53 | 2.63 |
| 5 x 3½ x 5/16 | 8.7 | 5.12 | 1.03 | 2.26 | 2.44 | 2.54 |
| 5 x 3 x 11/16 | 17.1 | 10.06 | 0.81 | 2.40 | 2.59 | 2.69 |
| 5 x 3 x 5/16 | 8.2 | 4.80 | 0.85 | 2.33 | 2.51 | 2.61 |
| 4½ x 3 x 11/16 | 16.0 | 9.36 | 0.83 | 2.12 | 2.32 | 2.42 |
| 4½ x 3 x 5/16 | 7.7 | 4.50 | 0.88 | 2.06 | 2.25 | 2.34 |
| 4 x 3½ x 13/16 | 18.5 | 10.86 | 1.01 | 1.81 | 2.01 | 2.11 |
| 4 x 3½ x 5/16 | 7.7 | 4.50 | 1.07 | 1.73 | 1.91 | 2.00 |
| 4 x 3 x 11/16 | 14.8 | 8.68 | 0.84 | 1.85 | 2.05 | 2.15 |
| 4 x 3 x 5/16 | 7.2 | 4.18 | 0.89 | 1.79 | 1.97 | 2.07 |
| 3½ x 3 x 11/16 | 13.6 | 8.00 | 0.86 | 1.59 | 1.78 | 1.88 |
| 3½ x 3 x ¼ | 5.4 | 3.12 | 0.91 | 1.52 | 1.70 | 1.79 |
| 3½ x 2½ x 9/16 | 10.4 | 6.12 | 0.70 | 1.63 | 1.83 | 1.93 |
| 3½ x 2½ x ¼ | 4.9 | 2.88 | 0.74 | 1.58 | 1.76 | 1.86 |
| 3 x 2½ x 9/16 | 9.5 | 5.56 | 0.72 | 1.36 | 1.56 | 1.66 |
| 3 x 2½ x ¼ | 4.5 | 2.62 | 0.75 | 1.31 | 1.50 | 1.59 |
| 3 x 2 x ½ | 7.7 | 4.50 | 0.55 | 1.42 | 1.62 | 1.72 |
| 3 x 2 x 3/16 | 3.07 | 1.82 | 0.58 | 1.37 | 1.55 | 1.65 |
| 2½ x 2 x ½ | 6.8 | 4.00 | 0.56 | 1.15 | 1.35 | 1.46 |
| 2½ x 2 x 3/16 | 2.75 | 1.62 | 0.60 | 1.10 | 1.28 | 1.38 |

# Radii of Gyration
## Continued

## For Two Unequal Legged Angles, Placed with Longer Legs Back to Back




| Size of Angles, Inches | Weight per Foot of Single Angle, Pounds | Area of Two Angles, Square Inches | Radii of Gyration | | | |
|---|---|---|---|---|---|---|
| | | | $r_0$ | $r_1$ | $r_2$ | $r_3$ |
| 8 x 6 x 1⅛ | 49.3 | 29.00 | 2.47 | 2.41 | 2.59 | 2.69 |
| 8 x 6 x ½ | 23.0 | 13.50 | 2.56 | 2.32 | 2.48 | 2.57 |
| 7 x 3½ x ⅞ | 28.7 | 16.84 | 2.20 | 1.28 | 1.47 | 1.57 |
| 7 x 3½ x 7/16 | 15.0 | 8.80 | 2.26 | 1.21 | 1.38 | 1.47 |
| 6 x 4 x 13/16 | 25.4 | 14.94 | 1.87 | 1.56 | 1.75 | 1.85 |
| 6 x 4 x ⅜ | 12.3 | 7.22 | 1.93 | 1.50 | 1.67 | 1.76 |
| 6 x 3½ x ¾ | 22.4 | 13.12 | 1.89 | 1.32 | 1.51 | 1.61 |
| 6 x 3½ x ⅜ | 11.7 | 6.84 | 1.94 | 1.26 | 1.43 | 1.53 |
| 5 x 4 x 13/16 | 22.7 | 13.30 | 1.53 | 1.64 | 1.83 | 1.93 |
| 5 x 4 x ⅜ | 11.0 | 6.46 | 1.59 | 1.58 | 1.75 | 1.85 |
| 5 x 3½ x ¾ | 19.8 | 11.62 | 1.55 | 1.40 | 1.59 | 1.69 |
| 5 x 3½ x 5/16 | 8.7 | 5.12 | 1.61 | 1.33 | 1.50 | 1.59 |
| 5 x 3 x 11/16 | 17.1 | 10.06 | 1.56 | 1.15 | 1.34 | 1.44 |
| 5 x 3 x 5/16 | 8.2 | 4.80 | 1.61 | 1.09 | 1.26 | 1.35 |
| 4½ x 3 x 11/16 | 16.0 | 9.36 | 1.39 | 1.19 | 1.38 | 1.48 |
| 4½ x 3 x 5/16 | 7.7 | 4.50 | 1.44 | 1.13 | 1.30 | 1.40 |
| 4 x 3½ x 13/16 | 18.5 | 10.86 | 1.19 | 1.50 | 1.69 | 1.79 |
| 4 x 3½ x 5/16 | 7.7 | 4.50 | 1.26 | 1.42 | 1.60 | 1.69 |
| 4 x 3 x 11/16 | 14.8 | 8.68 | 1.22 | 1.23 | 1.42 | 1.52 |
| 4 x 3 x 5/16 | 7.2 | 4.18 | 1.27 | 1.17 | 1.35 | 1.44 |
| 3½ x 3 x 11/16 | 13.6 | 8.00 | 1.05 | 1.28 | 1.48 | 1.57 |
| 3½ x 3 x ¼ | 5.4 | 3.12 | 1.11 | 1.20 | 1.38 | 1.48 |
| 3½ x 2½ x 9/16 | 10.4 | 6.12 | 1.08 | 1.01 | 1.20 | 1.31 |
| 3½ x 2½ x ¼ | 4.9 | 2.88 | 1.12 | 0.96 | 1.13 | 1.23 |
| 3 x 2½ x 9/16 | 9.5 | 5.56 | 0.91 | 1.05 | 1.25 | 1.35 |
| 3 x 2½ x ¼ | 4.5 | 2.62 | 0.95 | 1.00 | 1.18 | 1.28 |
| 3 x 2 x ½ | 7.7 | 4.50 | 0.92 | 0.80 | 1.00 | 1.10 |
| 3 x 2 x 3/16 | 3.07 | 1.82 | 0.97 | 0.75 | 0.93 | 1.03 |
| *2½ x 2 x ½* | 6.8 | 4.00 | 0.75 | 0.84 | 1.04 | 1.15 |
| *2½ x 2 x 3/16* | 2.75 | 1.62 | 0.79 | 0.79 | 0.97 | 1.07 |

# Radii of Gyration
Continued

## For Two Equal Legged Angles, Placed Back to Back


| Size of Angles, Inches | Weight per Foot of Single Angle, Pounds | Area of Two Angles, Square Inches | Radii of Gyration | | | |
|---|---|---|---|---|---|---|
| | | | $r_0$ | $r_1$ | $r_2$ | $r_3$ |
| 8 x 8 x 1⅛ | 56.9 | 33.46 | 2.42 | 3.42 | 3.60 | 3.69 |
| 8 x 8 x ½ | 26.4 | 15.50 | 2.51 | 3.33 | 3.50 | 3.59 |
| 6 x 6 x 1 | 37.4 | 22.00 | 1.80 | 2.59 | 2.77 | 2.87 |
| 6 x 6 x ⅜ | 14.9 | 8.72 | 1.88 | 2.49 | 2.67 | 2.76 |
| 5 x 5 x 15/16 | 28.9 | 17.00 | 1.48 | 2.17 | 2.36 | 2.46 |
| 5 x 5 x ⅜ | 12.3 | 7.22 | 1.56 | 2.09 | 2.26 | 2.35 |
| 4 x 4 x 13/16 | 19.9 | 11.68 | 1.18 | 1.75 | 1.94 | 2.04 |
| 4 x 4 x ¼ | 6.6 | 3.88 | 1.25 | 1.66 | 1.84 | 1.93 |
| 3½ x 3½ x ¾ | 16.0 | 9.38 | 1.03 | 1.54 | 1.74 | 1.84 |
| 3½ x 3½ x ¼ | 5.8 | 3.38 | 1.09 | 1.46 | 1.64 | 1.73 |
| 3 x 3 x ⅝ | 11.5 | 6.72 | 0.88 | 1.32 | 1.51 | 1.62 |
| 3 x 3 x ¼ | 4.9 | 2.88 | 0.93 | 1.25 | 1.43 | 1.53 |
| 2½ x 2½ x ½ | 7.7 | 4.50 | 0.74 | 1.10 | 1.29 | 1.40 |
| 2½ x 2½ x 3/16 | 3.07 | 1.80 | 0.78 | 1.04 | 1.22 | 1.32 |
| 2 x 2 x ½ | 6.0 | 3.50 | 0.58 | 0.89 | 1.09 | 1.20 |
| 2 x 2 x 3/16 | 2.44 | 1.42 | 0.62 | 0.84 | 1.03 | 1.13 |

# Struts

**Continued**

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
16,000—70 $\frac{1}{r}$ for lengths between 30 radii and 150 radii.

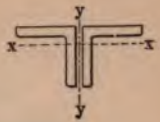
| Size of Angles, Inches | Area 2 Angles, Square Inches | Least Radius of Gyration, Inches | Axis of Least Radius of Gyration | Length in Feet | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 x 6 x 1⅛ | 29.00 | 2.47 | X-X | ...... | ...... | ...... | ...... | ...... | 395.0 |
| 8 x 6 x 1 | 26.00 | 2.49 | X-X | ...... | ...... | ...... | ...... | ...... | 354.6 |
| 8 x 6 x ⅞ | 22.96 | 2.51 | { X-X Y-Y } | ...... | ...... | ...... | ...... | ...... | 313.6 |
| 8 x 6 x ¾ | 19.88 | 2.48 | Y-Y | ...... | ...... | ...... | ...... | ...... | 270.9 |
| 8 x 6 x ⅝ | 16.72 | 2.46 | Y-Y | ...... | ...... | ...... | ...... | ...... | 227.6 |
| 8 x 6 x ½ | 13.50 | 2.44 | Y-Y | ...... | ...... | ...... | ...... | ...... | 183.5 |
| 7 x 3½ x ⅞ | 16.84 | 1.42 | Y-Y | ...... | ...... | 229.6 | 219.6 | 209.7 | 199.7 |
| 7 x 3½ x ¾ | 14.62 | 1.40 | Y-Y | ...... | ...... | 198.8 | 190.1 | 181.3 | 172.5 |
| 7 x 3½ x ⅝ | 12.34 | 1.37 | Y-Y | ...... | ...... | 167.2 | 159.6 | 152.0 | 144.5 |
| 7 x 3½ x ½ | 10.00 | 1.35 | Y-Y | ...... | ...... | 135.1 | 128.9 | 122.7 | 116.4 |
| 7 x 3½ x 7/16 | 8.80 | 1.33 | Y-Y | ...... | ...... | 118.6 | 113.0 | 107.5 | 101.9 |
| 6 x 4 x 13/16 | 14.94 | 1.70 | Y-Y | ...... | ...... | ...... | 202.1 | 194.7 | 187.4 |
| 6 x 4 x ¾ | 13.88 | 1.69 | Y-Y | ...... | ...... | ...... | 187.6 | 180.7 | 173.8 |
| 6 x 4 x ⅝ | 11.72 | 1.67 | Y-Y | ...... | ...... | ...... | 158.1 | 152.1 | 146.3 |
| 6 x 4 x ½ | 9.50 | 1.64 | Y-Y | ...... | ...... | ...... | 127.7 | 122.8 | 117.9 |
| 6 x 4 x ⅜ | 7.22 | 1.62 | Y-Y | ...... | ...... | ...... | 96.8 | 93.1 | 89.3 |
| 6 x 3½ x ¾ | 13.12 | 1.46 | Y-Y | ...... | ...... | 179.7 | 172.2 | 164.6 | 157.1 |
| 6 x 3½ x ⅝ | 11.10 | 1.43 | Y-Y | ...... | ...... | 151.5 | 145.0 | 138.5 | 132.0 |
| 6 x 3½ x ½ | 9.00 | 1.41 | Y-Y | ...... | ...... | 122.6 | 117.2 | 111.8 | 106.5 |
| 6 x 3½ x ⅜ | 6.84 | 1.39 | Y-Y | ...... | ...... | 92.9 | 88.8 | 84.6 | 80.5 |
| 5 x 4 x 13/16 | 13.30 | 1.53 | X-X | ...... | ...... | 183.6 | 176.3 | 169.0 | 161.7 |
| 5 x 4 x ¾ | 12.38 | 1.54 | X-X | ...... | ...... | 171.1 | 164.3 | 157.6 | 150.8 |
| 5 x 4 x ⅝ | 10.46 | 1.55 | X-X | ...... | ...... | 144.7 | 139.0 | 133.3 | 127.7 |
| 5 x 4 x ½ | 8.50 | 1.57 | X-X | ...... | ...... | 117.8 | 113.3 | 108.7 | 104.1 |
| 5 x 4 x ⅜ | 6.46 | 1.59 | X-X | ...... | ...... | 89.7 | 86.3 | 82.9 | 79.5 |
| 5 x 3½ x ¾ | 11.62 | 1.54 | Y-Y | ...... | ...... | 160.6 | 154.2 | 147.9 | 141.6 |
| 5 x 3½ x ⅝ | 9.84 | 1.51 | Y-Y | ...... | ...... | 135.5 | 130.1 | 124.6 | 119.1 |
| 5 x 3½ x ½ | 8.00 | 1.49 | Y-Y | ...... | ...... | 110.0 | 105.4 | 100.9 | 96.4 |
| 5 x 3½ x ⅜ | 6.10 | 1.46 | Y-Y | ...... | ...... | 83.6 | 80.1 | 76.5 | 73.0 |
| 5 x 3½ x 5/16 | 5.12 | 1.45 | Y-Y | ...... | ...... | 70.1 | 67.1 | 64.1 | 61.2 |
| 5 x 3 x 11/16 | 10.06 | 1.29 | Y-Y | ...... | ...... | 134.8 | 128.2 | 121.7 | 115.1 |
| 5 x 3 x ⅝ | 9.22 | 1.28 | Y-Y | ...... | ...... | 123.3 | 117.3 | 111.2 | 105.2 |
| 5 x 3 x ½ | 7.50 | 1.25 | Y-Y | ...... | ...... | 99.8 | 94.8 | 89.8 | 84.7 |
| 5 x 3 x ⅜ | 5.72 | 1.23 | Y-Y | ...... | ...... | 75.9 | 72.0 | 68.1 | 64.2 |
| 5 x 3 x 5/16 | 4.80 | 1.22 | Y-Y | ...... | ...... | 63.6 | 60.3 | 57.0 | 53.7 |

This table continued on next page.

## Safe Loads in Thousands of Pounds

## For Struts Composed of Two Angles with Unequal Legs

Long legs parallel and ⅜ inches apart.




Length in Feet

| 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 385.1 | 375.2 | 365.4 | 345.7 | 325.9 | 306.2 | 286.5 | 266.8 | 247.0 | 227.3 | 207.6 | 187.9 | 168.1 |
| 345.8 | 337.1 | 328.3 | 310.7 | 293.2 | 275.7 | 258.1 | 240.6 | 223.0 | 205.5 | 188.0 | 170.4 | 152.9 |
| 305.9 | 298.2 | 290.5 | 275.2 | 259.8 | 244.4 | 229.1 | 213.7 | 198.3 | 183.0 | 167.6 | 152.2 | 136.9 |
| 264.2 | 257.5 | 250.7 | 237.3 | 223.8 | 210.3 | 196.9 | 183.4 | 169.9 | 156.5 | 143.0 | 129.5 | 116.1 |
| 221.8 | 216.1 | 210.4 | 199.0 | 187.7 | 176.2 | 164.8 | 153.3 | 141.9 | 130.5 | 119.1 | 107.7 | 96.2 |
| 178.8 | 174.2 | 169.5 | 160.2 | 150.9 | 141.6 | 132.3 | 123.1 | 113.8 | 104.5 | 95.2 | 85.9 | 76.6 |
| 189.7 | 179.8 | 169.8 | 149.9 | 130.0 | 110.1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 163.7 | 155.0 | 146.2 | 128.7 | 111.1 | 93.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 136.9 | 129.3 | 121.8 | 106.6 | 91.5 | 76.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 110.2 | 104.0 | 97.8 | 85.3 | 72.9 | 60.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 96.3 | 90.8 | 85.2 | 74.1 | 63.0 | 51.9 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 180.0 | 172.6 | 165.2 | 150.5 | 135.7 | 120.9 | 106.2 | 91.4 | ...... | ...... | ...... | ...... | ...... |
| 166.9 | 160.0 | 153.1 | 139.3 | 125.5 | 111.7 | 97.9 | 84.1 | ...... | ...... | ...... | ...... | ...... |
| 140.4 | 134.5 | 128.6 | 116.8 | 105.0 | 93.2 | 81.4 | 69.6 | ...... | ...... | ...... | ...... | ...... |
| 113.1 | 108.2 | 103.3 | 93.6 | 83.8 | 74.1 | 64.3 | 54.6 | ...... | ...... | ...... | ...... | ...... |
| 85.6 | 81.8 | 78.1 | 70.6 | 63.1 | 55.6 | 48.1 | 40.7 | ...... | ...... | ...... | ...... | ...... |
| 149.5 | 142.0 | 134.4 | 119.3 | 104.2 | 89.2 | 74.1 | ...... | ...... | ...... | ...... | ...... | ...... |
| 125.4 | 118.9 | 112.4 | 99.4 | 86.3 | 73.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 101.1 | 95.7 | 90.4 | 79.7 | 68.9 | 58.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 76.4 | 72.2 | 68.1 | 59.8 | 51.6 | 43.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 154.4 | 147.1 | 139.8 | 125.2 | 110.6 | 96.0 | 81.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| 144.1 | 137.3 | 130.6 | 117.0 | 103.5 | 90.0 | 76.5 | ...... | ...... | ...... | ...... | ...... | ...... |
| 122.0 | 116.3 | 110.7 | 99.3 | 88.0 | 76.6 | 65.3 | ...... | ...... | ...... | ...... | ...... | ...... |
| 99.6 | 95.0 | 90.5 | 81.4 | 72.3 | 63.1 | 54.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| 76.0 | 72.6 | 69.2 | 62.4 | 55.5 | 48.7 | 41.9 | ...... | ...... | ...... | ...... | ...... | ...... |
| 135.2 | 128.9 | 122.5 | 109.9 | 91.2 | 84.5 | 71.8 | ...... | ...... | ...... | ...... | ...... | ...... |
| 113.7 | 108.2 | 102.7 | 91.8 | 80.8 | 69.9 | 59.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| 91.9 | 87.4 | 82.9 | 73.9 | 64.9 | 55.8 | 46.8 | ...... | ...... | ...... | ...... | ...... | ...... |
| 69.5 | 66.0 | 62.5 | 55.5 | 48.5 | 41.5 | 34.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| 58.2 | 55.2 | 52.3 | 46.3 | 40.4 | 34.5 | 28.5 | ...... | ...... | ...... | ...... | ...... | ...... |
| 108.6 | 102.0 | 95.5 | 82.4 | 69.3 | 56.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 99.1 | 93.1 | 87.0 | 74.9 | 62.8 | 50.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 79.7 | 74.6 | 69.6 | 50.5 | 49.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 60.3 | 56.4 | 52.5 | 44.6 | 36.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 50.4 | 47.0 | 43.7 | 37.1 | 30.5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

# Struts

## Continued

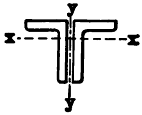
Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
16,000—70 $\frac{1}{r}$ for lengths between 30 radii and 150 radii.

| Size of Angles, Inches | Area 2 Angles, Square Inches | Least Radius of Gyration, Inches | Axis of Least Radius of Gyration | Length in Feet | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 | 5 | 6 | 7 |
| 4½ x 3 x 11/16 | 9.36 | 1.33 | Y-Y | ...... | ...... | 126.1 | 120.2 | 114.3 | 108.4 |
| 4½ x 3 x 5/8 | 8.60 | 1.31 | Y-Y | ...... | ...... | 115.5 | 110.0 | 104.5 | 99.0 |
| 4½ x 3 x ½ | 7.00 | 1.29 | Y-Y | ...... | ...... | 93.8 | 89.2 | 84.7 | 80.1 |
| 4½ x 3 x 3/8 | 5.34 | 1.27 | Y-Y | ...... | ...... | 71.3 | 67.8 | 64.2 | 60.7 |
| 4½ x 3 x 5/16 | 4.50 | 1.26 | Y-Y | ...... | ...... | 60.0 | 57.0 | 54.0 | 51.0 |
| 4 x 3½ x 13/16 | 10.86 | 1.19 | X-X | ...... | 150.8 | 143.1 | 135.4 | 127.8 | 120.1 |
| 4 x 3½ x ¾ | 10.12 | 1.20 | X-X | ...... | 140.7 | 133.6 | 126.5 | 119.4 | 112.3 |
| 4 x 3½ x 5/8 | 8.60 | 1.22 | X-X | ...... | ...... | 113.9 | 108.0 | 102.1 | 96.2 |
| 4 x 3½ x ½ | 7.00 | 1.23 | X-X | ...... | ...... | 92.9 | 88.1 | 83.3 | 78.5 |
| 4 x 3½ x 3/8 | 5.34 | 1.25 | X-X | ...... | ...... | 71.1 | 67.5 | 63.9 | 60.3 |
| 4 x 3½ x 5/16 | 4.50 | 1.26 | X-X | ...... | ...... | 60.0 | 57.0 | 54.0 | 51.0 |
| 4 x 3 x 11/16 | 8.68 | 1.22 | X-X | ...... | ...... | 115.0 | 109.0 | 103.0 | 97.0 |
| 4 x 3 x 5/8 | 7.96 | 1.23 | X-X | ...... | ...... | 105.6 | 100.1 | 94.7 | 89.3 |
| 4 x 3 x ½ | 6.50 | 1.25 | X-X | ...... | ...... | 86.5 | 82.2 | 77.8 | 73.4 |
| 4 x 3 x 3/8 | 4.96 | 1.26 | X-X | ...... | ...... | 66.1 | 62.8 | 59.5 | 56.2 |
| 4 x 3 x 5/16 | 4.18 | 1.27 | X-X | ...... | ...... | 55.8 | 53.1 | 50.3 | 47.5 |
| 3½ x 3 x 11/16 | 8.00 | 1.05 | X-X | ...... | 108.8 | 102.4 | 96.0 | 89.6 | 83.2 |
| 3½ x 3 x 5/8 | 7.34 | 1.06 | X-X | ...... | 100.0 | 94.2 | 88.4 | 82.5 | 76.7 |
| 3½ x 3 x ½ | 6.00 | 1.07 | X-X | ...... | 81.9 | 77.2 | 72.4 | 67.7 | 63.0 |
| 3½ x 3 x 3/8 | 4.60 | 1.09 | X-X | ...... | 63.0 | 59.4 | 55.9 | 52.3 | 48.8 |
| 3½ x 3 x ¼ | 3.12 | 1.11 | X-X | ...... | 42.8 | 40.5 | 38.1 | 35.8 | 33.4 |
| 3½ x 2½ x 9/16 | 6.12 | 1.08 | X-X | ...... | 83.6 | 78.9 | 74.1 | 69.4 | 64.6 |
| 3½ x 2½ x ½ | 5.50 | 1.09 | X-X | ...... | 75.3 | 71.0 | 66.8 | 62.6 | 58.3 |
| 3½ x 2½ x 3/8 | 4.22 | 1.10 | X-X | ...... | 57.9 | 54.6 | 51.4 | 48.2 | 45.0 |
| 3½ x 2½ x ¼ | 2.88 | 1.09 | Y-Y | ...... | 39.4 | 37.2 | 35.0 | 32.8 | 30.5 |
| 3 x 2½ x 9/16 | 5.56 | .91 | X-X | ...... | 73.6 | 68.4 | 63.3 | 58.2 | 53.0 |
| 3 x 2½ x ½ | 5.00 | .91 | X-X | ...... | 66.2 | 61.5 | 56.9 | 52.3 | 47.7 |
| 3 x 2½ x 3/8 | 3.84 | .93 | X-X | ...... | 51.0 | 47.6 | 44.1 | 40.6 | 37.2 |
| 3 x 2½ x ¼ | 2.62 | .95 | X-X | ...... | 35.0 | 32.7 | 30.3 | 28.0 | 25.7 |
| 3 x 2 x ½ | 4.50 | .92 | X-X | ...... | 59.7 | 55.6 | 51.5 | 47.3 | 43.2 |
| 3 x 2 x 3/8 | 3.46 | .92 | Y-Y | ...... | 45.9 | 42.7 | 39.6 | 36.4 | 33.2 |
| 3 x 2 x ¼ | 2.38 | .89 | Y-Y | ...... | 31.3 | 29.1 | 26.9 | 24.6 | 22.4 |
| 3 x 2 x 3/16 | 1.82 | .88 | Y-Y | ...... | 23.9 | 22.2 | 20.4 | 18.7 | 17.0 |
| 2½ x 2 x ½ | 4.00 | .75 | X-X | 55.0 | 50.6 | 46.1 | 41.6 | 37.1 | 32.6 |
| 2½ x 2 x 3/8 | 3.10 | .77 | X-X | 42.8 | 39.5 | 36.1 | 32.7 | 29.3 | 25.9 |
| 2½ x 2 x ¼ | 2.12 | .78 | X-X | 29.4 | 27.1 | 24.8 | 22.5 | 20.2 | 17.9 |
| 2½ x 2 x 3/16 | 1.62 | .79 | X-X | 22.5 | 28.0 | 19.0 | 17.3 | 15.6 | 13.9 |

This table continued on next page.

## Safe Loads in Thousands of Pounds

## For Struts Composed of Two Angles with Unequal Legs




**Long legs parallel and ⅜ inches apart.**

Length in Feet

| 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102.5 | 96.6 | 90.6 | 78.8 | 67.0 | 55.2 | | | | | | | |
| 93.5 | 88.0 | 82.5 | 71.4 | 60.4 | 49.4 | | | | | | | |
| 75.5 | 71.0 | 66.4 | 57.3 | 48.2 | 39.1 | | | | | | | |
| 57.2 | 53.6 | 50.1 | 43.0 | 36.0 | | | | | | | | |
| 48.0 | 45.0 | 42.0 | 36.0 | 30.0 | | | | | | | | |
| 112.4 | 104.8 | 97.1 | 81.8 | 66.4 | | | | | | | | |
| 105.2 | 98.2 | 91.1 | 76.9 | 62.7 | | | | | | | | |
| 90.2 | 84.3 | 78.4 | 66.5 | 54.7 | | | | | | | | |
| 73.8 | 69.0 | 64.2 | 54.6 | 45.1 | | | | | | | | |
| 56.7 | 53.1 | 49.6 | 42.4 | 35.2 | | | | | | | | |
| 48.0 | 45.0 | 42.0 | 36.0 | 30.0 | | | | | | | | |
| 91.1 | 85.1 | 79.1 | 67.2 | 55.2 | | | | | | | | |
| 83.9 | 78.4 | 73.0 | 62.1 | 51.3 | | | | | | | | |
| 69.1 | 64.7 | 60.3 | 51.6 | 42.8 | | | | | | | | |
| 52.9 | 49.6 | 46.3 | 39.7 | 33.1 | | | | | | | | |
| 44.8 | 42.0 | 39.2 | 33.7 | 28.2 | | | | | | | | |
| 76.8 | 70.4 | 64.0 | 51.2 | | | | | | | | | |
| 70.9 | 65.1 | 59.3 | 47.6 | | | | | | | | | |
| 58.3 | 53.6 | 48.9 | 39.5 | | | | | | | | | |
| 45.2 | 41.7 | 38.2 | 31.1 | | | | | | | | | |
| 31.0 | 28.7 | 26.3 | 21.6 | | | | | | | | | |
| 59.8 | 55.1 | 50.3 | 40.8 | | | | | | | | | |
| 54.1 | 49.9 | 45.6 | 37.1 | | | | | | | | | |
| 41.7 | 38.5 | 35.3 | 28.9 | | | | | | | | | |
| 28.3 | 26.1 | 23.9 | 19.4 | | | | | | | | | |
| 47.9 | 42.8 | 37.6 | | | | | | | | | | |
| 43.1 | 38.5 | 33.8 | | | | | | | | | | |
| 33.7 | 30.2 | 26.8 | | | | | | | | | | |
| 23.4 | 21.1 | 18.8 | | | | | | | | | | |
| 39.1 | 35.0 | 30.9 | | | | | | | | | | |
| 30.1 | 26.9 | 23.8 | | | | | | | | | | |
| 20.1 | 17.9 | 15.6 | | | | | | | | | | |
| 15.2 | 13.5 | 11.7 | | | | | | | | | | |
| 28.2 | 23.7 | | | | | | | | | | | |
| 22.5 | 19.2 | | | | | | | | | | | |
| 15.7 | 13.4 | | | | | | | | | | | |
| 12.1 | 10.4 | | | | | | | | | | | |

# Struts

**Continued**

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000-70\,\frac{1}{r}$ for lengths between 30 radii and 150 radii.

| Size of Angles, Inches | Area 2 Angles, Square Inches | Least Radius of Gyration, Inches | Axis of Least Radius of Gyration | Length in Feet | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 x 8 x 1⅛ | 33.46 | 2.42 | X-X | ...... | ...... | ...... | ...... | ...... | 454.1 |
| 8 x 8 x 1 | 30.00 | 2.44 | X-X | ...... | ...... | ...... | ...... | ...... | 407.7 |
| 8 x 8 x ⅞ | 26.46 | 2.45 | X-X | ...... | ...... | ...... | ...... | ...... | 359.9 |
| 8 x 8 x ¾ | 22.88 | 2.47 | X-X | ...... | ...... | ...... | ...... | ...... | 311.5 |
| 8 x 8 x ⅝ | 19.22 | 2.49 | X-X | ...... | ...... | ...... | ...... | ...... | 262.1 |
| 8 x 8 x ½ | 15.50 | 2.50 | X-X | ...... | ...... | ...... | ...... | ...... | 211.6 |
| 6 x 6 x 1 | 22.00 | 1.80 | X-X | ...... | ...... | ...... | 300.7 | 290.4 | 280.1 |
| 6 x 6 x ⅞ | 19.46 | 1.81 | X-X | ...... | ...... | ...... | 266.2 | 257.2 | 248.2 |
| 6 x 6 x ¾ | 16.88 | 1.83 | X-X | ...... | ...... | ...... | 231.3 | 223.6 | 215.8 |
| 6 x 6 x ⅝ | 14.22 | 1.84 | X-X | ...... | ...... | ...... | 195.1 | 188.6 | 182.1 |
| 6 x 6 x ½ | 11.50 | 1.86 | X-X | ...... | ...... | ...... | 158.0 | 152.8 | 147.6 |
| 6 x 6 x ⅜ | 8.72 | 1.88 | X-X | ...... | ...... | ...... | 120.0 | 116.1 | 112.2 |
| 5 x 5 x 13/16 | 17.00 | 1.48 | X-X | ...... | ...... | 233.4 | 223.8 | 214.1 | 204.5 |
| 5 x 5 x ⅞ | 15.96 | 1.49 | X-X | ...... | ...... | 219.4 | 210.4 | 201.4 | 192.4 |
| 5 x 5 x ¾ | 13.88 | 1.51 | X-X | ...... | ...... | 191.2 | 183.5 | 175.8 | 168.0 |
| 5 x 5 x ⅝ | 11.72 | 1.52 | X-X | ...... | ...... | 161.6 | 155.1 | 148.7 | 142.2 |
| 5 x 5 x ½ | 9.50 | 1.54 | X-X | ...... | ...... | 131.3 | 126.1 | 120.9 | 115.7 |
| 5 x 5 x ⅜ | 7.22 | 1.56 | X-X | ...... | ...... | 100.0 | 96.1 | 92.2 | 88.3 |
| 4 x 4 x 13/16 | 11.68 | 1.18 | X-X | ...... | 161.9 | 153.6 | 145.3 | 137.0 | 128.7 |
| 4 x 4 x ¾ | 10.88 | 1.19 | X-X | ...... | 151.0 | 143.4 | 135.7 | 128.0 | 120.3 |
| 4 x 4 x ⅝ | 9.22 | 1.20 | X-X | ...... | 128.2 | 121.7 | 115.3 | 108.8 | 102.3 |
| 4 x 4 x ½ | 7.50 | 1.22 | X-X | ...... | ...... | 99.3 | 97.2 | 89.0 | 83.8 |
| 4 x 4 x ⅜ | 5.72 | 1.23 | X-X | ...... | ...... | 75.9 | 72.0 | 68.1 | 64.2 |
| 4 x 4 x ¼ | 3.88 | 1.25 | X-X | ...... | ...... | 51.6 | 49.0 | 46.4 | 43.8 |
| 3½ x 3½ x ¾ | 9.38 | 1.03 | X-X | ...... | 127.1 | 119.5 | 111.8 | 104.2 | 96.5 |
| 3½ x 3½ x ⅝ | 7.96 | 1.04 | X-X | ...... | 108.1 | 101.6 | 95.2 | 88.8 | 82.4 |
| 3½ x 3½ x ½ | 6.50 | 1.06 | X-X | ...... | 88.5 | 83.4 | 78.2 | 73.1 | 67.9 |
| 3½ x 3½ x ⅜ | 4.96 | 1.07 | X-X | ...... | 67.7 | 63.8 | 59.9 | 56.0 | 52.1 |
| 3½ x 3½ x ¼ | 3.38 | 1.09 | X-X | ...... | 46.3 | 43.7 | 41.1 | 38.4 | 35.8 |
| 3 x 3 x ⅝ | 6.72 | 0.88 | X-X | ...... | 88.3 | 81.9 | 75.4 | 69.0 | 62.6 |
| 3 x 3 x ½ | 5.50 | 0.90 | X-X | ...... | 72.6 | 67.5 | 62.3 | 57.2 | 52.1 |
| 3 x 3 x ⅜ | 4.22 | 0.91 | X-X | ...... | 55.8 | 51.9 | 48.0 | 44.1 | 40.3 |
| 3 x 3 x ¼ | 2.88 | 0.93 | X-X | ...... | 38.3 | 35.7 | 33.1 | 30.5 | 27.9 |
| 2½ x 2½ x ½ | 4.50 | 0.74 | X-X | 61.8 | 56.7 | 51.6 | 46.5 | 41.4 | 36.2 |
| 2½ x 2½ x ⅜ | 3.46 | 0.75 | X-X | 47.6 | 43.7 | 39.9 | 36.0 | 32.1 | 28.2 |
| 2½ x 2½ x 5/16 | 2.94 | 0.76 | X-X | 40.5 | 37.3 | 34.0 | 30.8 | 27.5 | 24.3 |
| 2½ x 2½ x ¼ | 2.38 | 0.77 | X-X | 32.9 | 30.3 | 27.7 | 25.1 | 22.5 | 19.9 |
| 2½ x 2½ x 3/16 | 1.80 | 0.78 | X-X | 24.9 | 23.0 | 21.0 | 19.1 | 17.2 | 15.2 |
| 2 x 2 x ½ | 3.50 | 0.58 | X-X | 45.9 | 40.8 | 35.7 | 30.7 | 25.6 | 20.5 |
| 2 x 2 x ⅜ | 2.72 | 0.59 | X-X | 35.8 | 31.9 | 28.0 | 24.2 | 20.3 | 16.4 |
| 2 x 2 x 5/16 | 2.30 | 0.60 | X-X | 30.4 | 27.1 | 23.9 | 20.7 | 17.5 | 14.3 |
| 2 x 2 x ¼ | 1.88 | 0.61 | X-X | 24.9 | 22.3 | 19.7 | 17.1 | 14.5 | 12.0 |
| 2 x 2 x 3/16 | 1.42 | 0.62 | X-X | 18.9 | 16.9 | 15.0 | 13.1 | 11.2 | 9.3 |

This table continued on next page.

## Safe Loads in Thousands of Pounds

## For Struts Composed of Two Angles with Equal Legs


Parallel legs ⅜ inches apart.

| Length in Feet | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
| 442.4 | 430.8 | 419.2 | 396.0 | 372.8 | 349.5 | 326.3 | 303.1 | 279.9 | 256.6 | 233.4 | 210.2 | 186.9 |
| 397.4 | 387.0 | 376.7 | 356.1 | 335.4 | 314.7 | 294.1 | 273.4 | 252.8 | 232.1 | 211.4 | 190.8 | 170.1 |
| 350.8 | 341.7 | 332.6 | 314.5 | 296.4 | 278.2 | 260.1 | 241.9 | 223.8 | 205.7 | 187.5 | 169.4 | 151.2 |
| 303.7 | 296.0 | 288.3 | 272.7 | 257.1 | 241.6 | 226.0 | 210.5 | 194.9 | 179.3 | 163.8 | 148.2 | 132.6 |
| 255.6 | 249.2 | 242.7 | 229.7 | 216.7 | 203.8 | 190.8 | 177.8 | 164.9 | 151.9 | 138.9 | 125.9 | 113.0 |
| 206.3 | 201.1 | 195.9 | 185.5 | 175.1 | 164.7 | 154.3 | 143.8 | 133.4 | 123.0 | 112.6 | 102.2 | 91.8 |
| 269.9 | 259.6 | 249.3 | 228.8 | 208.3 | 187.8 | 167.2 | 146.7 | 126.2 | ...... | ...... | ...... | ...... |
| 239.1 | 230.1 | 221.1 | 203.0 | 184.9 | 166.9 | 148.8 | 130.8 | 112.7 | ...... | ...... | ...... | ...... |
| 208.1 | 200.3 | 192.6 | 177.1 | 161.6 | 146.1 | 130.6 | 115.1 | 99.6 | ...... | ...... | ...... | ...... |
| 175.6 | 169.1 | 162.6 | 149.6 | 136.6 | 123.6 | 110.6 | 97.7 | 84.7 | ...... | ...... | ...... | ...... |
| 142.4 | 137.3 | 132.1 | 121.7 | 111.3 | 100.9 | 90.5 | 80.1 | 69.7 | ...... | ...... | ...... | ...... |
| 108.4 | 104.5 | 100.6 | 92.8 | 85.0 | 77.2 | 69.4 | 61.6 | 53.8 | ...... | ...... | ...... | ...... |
| 194.8 | 185.2 | 175.5 | 156.2 | 136.9 | 117.6 | 98.3 | ...... | ...... | ...... | ...... | ...... | ...... |
| 183.4 | 174.4 | 165.4 | 147.4 | 129.4 | 111.4 | 93.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| 160.3 | 152.6 | 144.9 | 129.4 | 114.0 | 98.6 | 83.1 | ...... | ...... | ...... | ...... | ...... | ...... |
| 135.7 | 129.2 | 122.8 | 109.8 | 96.9 | 83.9 | 70.9 | ...... | ...... | ...... | ...... | ...... | ...... |
| 110.5 | 105.4 | 100.2 | 89.8 | 79.5 | 69.1 | 58.7 | ...... | ...... | ...... | ...... | ...... | ...... |
| 84.4 | 80.5 | 76.6 | 68.9 | 61.1 | 53.3 | 45.6 | ...... | ...... | ...... | ...... | ...... | ...... |
| 120.4 | 112.1 | 103.7 | 87.1 | 70.5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 112.6 | 105.0 | 97.3 | 81.9 | 66.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 95.9 | 89.4 | 83.0 | 70.1 | 57.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 78.7 | 73.5 | 68.4 | 58.0 | 47.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 60.3 | 56.4 | 52.5 | 44.6 | 36.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 41.2 | 38.6 | 36.0 | 30.8 | 25.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 88.9 | 81.2 | 73.6 | 58.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 75.9 | 69.5 | 63.1 | 50.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 62.8 | 57.6 | 52.5 | 42.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 48.2 | 44.3 | 40.4 | 32.5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 33.2 | 30.6 | 28.0 | 22.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 56.2 | 49.8 | 43.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 46.9 | 41.8 | 36.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 36.4 | 32.5 | 28.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 25.3 | 22.7 | 20.1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 31.1 | 26.0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 24.4 | 20.5 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 21.0 | 17.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 17.3 | 14.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 13.3 | 11.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

# Struts

## Continued

Allowed stresses per square inch.
14,000 pounds for lengths less than 30 radii.
$16{,}000—70\,\frac{l}{r}$ for lengths between 30 radii and 150 radii.

| Size of Angle, Inches | Area of Angle, Square Inches | Least Radius of Gyration, Inches | Length in Feet | | | |
|---|---|---|---|---|---|---|
| | | | 2 | 3 | 4 | 5 |
| 8 x 8 x 1⅛ | 16.73 | 1.55 | ........ | ........ | 231.4 | 222.3 |
| 8 x 8 x 1 | 15.00 | 1.56 | ........ | ........ | 207.7 | 199.6 |
| 8 x 8 x ⅞ | 13.23 | 1.56 | ........ | ........ | 183.2 | 176.1 |
| 8 x 8 x ¾ | 11.44 | 1.57 | ........ | ........ | 158.6 | 152.4 |
| 8 x 8 x ⅝ | 9.61 | 1.58 | ........ | ........ | 133.3 | 128.2 |
| 8 x 8 x ½ | 7.75 | 1.59 | ........ | ........ | 107.6 | 103.5 |
| 6 x 6 x 1 | 11.00 | 1.16 | ........ | 152.1 | 144.1 | 136.2 |
| 6 x 6 x ⅞ | 9.73 | 1.16 | ........ | 134.5 | 127.5 | 120.5 |
| 6 x 6 x ¾ | 8.44 | 1.17 | ........ | 116.9 | 110.8 | 104.7 |
| 6 x 6 x ⅝ | 7.11 | 1.17 | ........ | 98.4 | 93.3 | 88.2 |
| 6 x 6 x ½ | 5.75 | 1.18 | ........ | 79.7 | 75.6 | 71.6 |
| 6 x 6 x ⅜ | 4.36 | 1.19 | ........ | 60.5 | 57.5 | 54.4 |
| 5 x 5 x 15/16 | 8.50 | .96 | ........ | 113.7 | 106.2 | 98.8 |
| 5 x 5 x ⅞ | 7.98 | .96 | ........ | 106.7 | 99.8 | 92.8 |
| 5 x 5 x ¾ | 6.94 | .97 | ........ | 93.0 | 87.0 | 81.0 |
| 5 x 5 x ⅝ | 5.86 | .97 | ........ | 78.5 | 73.5 | 68.4 |
| 5 x 5 x ½ | 4.75 | .98 | ........ | 63.8 | 59.7 | 55.6 |
| 5 x 5 x ⅜ | 3.61 | .99 | ........ | 48.6 | 45.5 | 42.4 |
| 4 x 4 x 13/16 | 5.84 | .77 | 80.7 | 74.3 | 68.0 | 61.6 |
| 4 x 4 x ¾ | 5.44 | .77 | 75.2 | 69.2 | 63.3 | 57.4 |
| 4 x 4 x ⅝ | 4.61 | .77 | 63.7 | 58.7 | 53.6 | 48.6 |
| 4 x 4 x ½ | 3.75 | .78 | 51.9 | 47.9 | 43.8 | 39.8 |
| 4 x 4 x ⅜ | 2.86 | .79 | 39.7 | 36.6 | 33.6 | 30.5 |
| 4 x 4 x ¼ | 1.94 | .79 | 26.9 | 24.8 | 22.8 | 20.7 |
| 3½ x 3½ x ¾ | 4.69 | .67 | 63.3 | 57.4 | 51.5 | 45.7 |
| 3½ x 3½ x ⅝ | 3.98 | .68 | 53.8 | 48.9 | 44.0 | 39.1 |
| 3½ x 3½ x ½ | 3.25 | .68 | 44.0 | 40.0 | 35.9 | 31.9 |
| 3½ x 3½ x ⅜ | 2.48 | .68 | 33.6 | 30.5 | 27.4 | 24.4 |
| 3½ x 3½ x ¼ | 1.69 | .69 | 22.9 | 20.9 | 18.8 | 16.8 |
| 3 x 3 x ⅝ | 3.36 | .58 | 44.0 | 39.2 | 34.3 | 29.4 |
| 3 x 3 x ½ | 2.75 | .58 | 36.0 | 32.1 | 28.1 | 24.1 |
| 3 x 3 x ⅜ | 2.11 | .58 | 27.6 | 24.6 | 21.5 | 18.5 |
| 3 x 3 x ¼ | 1.44 | .59 | 18.9 | 16.9 | 14.8 | 12.8 |
| 3 x 3 x 3/16 | 1.09 | .60 | 14.4 | 12.9 | 11.3 | 9.8 |
| 2½ x 2½ x ½ | 2.25 | .48 | 28.1 | 24.2 | 20.3 | 16.3 |
| 2½ x 2½ x ⅜ | 1.73 | .48 | 21.6 | 18.6 | 15.6 | 12.5 |
| 2½ x 2½ x 5/16 | 1.47 | .49 | 18.5 | 16.0 | 13.4 | 10.9 |
| 2½ x 2½ x ¼ | 1.19 | .49 | 15.0 | 12.9 | 10.9 | 8.8 |
| 2½ x 2½ x 3/16 | .90 | .49 | 11.3 | 9.8 | 8.2 | 6.7 |
| 2 x 2 x ½ | 1.75 | .38 | 20.3 | 16.4 | 12.5 | ........ |
| 2 x 2 x ⅜ | 1.36 | .39 | 15.9 | 13.0 | 10.0 | ........ |
| 2 x 2 x 5/16 | 1.15 | .39 | 13.4 | 11.0 | 8.5 | ........ |
| 2 x 2 x ¼ | .94 | .39 | 11.0 | 9.0 | 6.9 | ........ |
| 2 x 2 x 3/16 | .71 | .39 | 8.3 | 6.8 | 5.2 | ........ |

This table continued on next page.

## Safe Loads in Thousands of Pounds
## For Equal Leg Single Angle Struts

| Length in Feet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 | 18 |
| 213.3 | 204.2 | 195.1 | 186.1 | 177.0 | 158.9 | 140.8 | 122.6 | 104.5 |
| 191.5 | 183.5 | 175.4 | 167.3 | 159.2 | 143.1 | 126.9 | 110.8 | 94.6 |
| 168.9 | 161.8 | 154.7 | 147.6 | 140.4 | 126.2 | 111.9 | 97.7 | 83.5 |
| 146.3 | 140.2 | 134.1 | 128.0 | 121.8 | 109.6 | 97.4 | 85.1 | 72.9 |
| 123.1 | 118.0 | 112.9 | 107.8 | 102.7 | 92.5 | 82.2 | 72.0 | 61.8 |
| 99.4 | 95.3 | 91.3 | 87.2 | 83.1 | 74.9 | 66.7 | 58.5 | 50.3 |
| 128.2 | 120.2 | 112.3 | 104.3 | 96.3 | 80.4 | 64.5 | ........ | ........ |
| 113.4 | 106.4 | 99.3 | 92.3 | 85.2 | 71.1 | 57.0 | ........ | ........ |
| 98.7 | 92.6 | 86.6 | 80.5 | 74.4 | 62.3 | 50.2 | ........ | ........ |
| 83.1 | 78.0 | 72.9 | 67.8 | 62.7 | 52.5 | 42.3 | ........ | ........ |
| 67.5 | 63.4 | 59.3 | 55.2 | 51.1 | 42.9 | 34.7 | ........ | ........ |
| 51.3 | 48.2 | 45.1 | 42.1 | 39.0 | 32.8 | 26.7 | ........ | ........ |
| 91.4 | 83.9 | 76.5 | 69.1 | 61.6 | 46.8 | ........ | ........ | ........ |
| 85.8 | 78.8 | 71.8 | 64.8 | 57.9 | 43.9 | ........ | ........ | ........ |
| 75.0 | 69.0 | 63.0 | 57.0 | 50.9 | 38.9 | ........ | ........ | ........ |
| 63.3 | 58.2 | 53.2 | 48.1 | 43.0 | 32.9 | ........ | ........ | ........ |
| 51.6 | 47.5 | 43.4 | 39.4 | 35.3 | 27.1 | ........ | ........ | ........ |
| 39.4 | 36.3 | 33.3 | 30.2 | 27.1 | 21.0 | ........ | ........ | ........ |
| 55.2 | 48.8 | 42.5 | 36.1 | ........ | ........ | ........ | ........ | ........ |
| 51.4 | 45.5 | 39.6 | 33.6 | ........ | ........ | ........ | ........ | ........ |
| 43.6 | 38.6 | 33.5 | 28.5 | ........ | ........ | ........ | ........ | ........ |
| 35.8 | 31.7 | 27.7 | 23.7 | ........ | ........ | ........ | ........ | ........ |
| 27.5 | 24.5 | 21.4 | 18.4 | ........ | ........ | ........ | ........ | ........ |
| 18.7 | 16.6 | 14.5 | 12.5 | ........ | ........ | ........ | ........ | ........ |
| 39.8 | 33.9 | 28.0 | ........ | ........ | ........ | ........ | ........ | ........ |
| 34.2 | 29.3 | 24.4 | ........ | ........ | ........ | ........ | ........ | ........ |
| 27.9 | 23.9 | 19.9 | ........ | ........ | ........ | ........ | ........ | ........ |
| 21.3 | 18.2 | 15.2 | ........ | ........ | ........ | ........ | ........ | ........ |
| 14.7 | 12.6 | 10.6 | ........ | ........ | ........ | ........ | ........ | ........ |
| 24.6 | 19.7 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 20.1 | 16.1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 15.4 | 12.4 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 10.7 | 8.7 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 8.3 | 6.8 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 12.4 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 9.5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 8.4 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 6.8 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| 5.1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## Foundation Grillages

As a means of avoiding large masses of masonry and deep excavations, it has become the practice to use in foundation work, grillages composed of beams imbedded in concrete. These grillages are constructed of one, two or three layers of beams, depending on the load to be carried and the capacity of the earth to resist pressure. Such beams should be spaced at least 2½" or 3" apart in the clear between flanges, so as to enable the concrete to be readily placed and tamped.

The top tier of beams in all cases should be held in position and alignment by bolting the beams together by tie rods with separators made of gas pipe. Where more than one tier of beams is used, it is not the custom to use separators and tie rods on the lower tiers. Pipe separators are preferable to the usual cast iron separators as they interfere less with the continuity of the concrete.

In the design of grillages, it is customary to assume that the load supported by each beam in a tier is equal to the total load on the foundation, divided by the number of beams in that tier; also, that such loading is uniformly distributed over that portion of the top flange to which it is applied, and that the beam is supported with a uniform pressure from below over its entire length.

Under these conditions, the maximum bending moment occurs at the center of the length of the beam, and is given by the formula $\frac{W\,(L-N)}{8}$ in which $W$ equals the load supported by each beam in pounds, $L$ equals the length of beam in feet, and $N$ the length in feet in which load is applied. This formula, it will be noted, is the same as that for a beam supported at each end and uniformly loaded, the length of which corresponds with the dimension of $L-N$ in the above formula. By the use of this length of $L-N$ as a span, it is possible to pick the size of grillage beams direct from the tables of safe loads for beams, as published in this book. It should be noted, however, that if the dimension of $L-N$ is less than the span given in these tables that there is great danger of the shear in the beam being in excess of the capacity of the beam webs to resist such shear.

Where beams are thoroughly imbedded in concrete and the webs ·vented from buckling, the grillage beam would ordinarily be ·*dered safe in* shear, if such shear did not exceed in intensity

# Foundation Grillages

**Continued**

12,000 pounds per square inch of web area, this web area being the depth of the beam, multiplied by its web thickness.

To transmit the load from the columns to the top tier of grillage beams, it is usually economical to use a rolled steel slab in place of either riveted bases on the columns or of separate cast iron bases.

The size of the slab is usually determined by the outside dimensions of the column and the width of the top tier of grillage beams. In figuring the thickness of the slabs, the assumption of uniform distribution of load made in the case of the grillage beams cannot hold except as to the reaction on the underside of the slab.

The maximum moment in the slab will be along a line practically coincident with the outside lines of the column section.

## Slabs

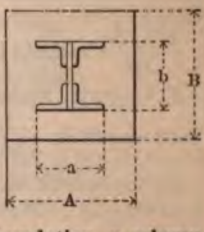
As a direct means of determining the thickness of the distribution slabs, the following formulae may be used.

$t = \sqrt{\dfrac{3w\ (B - b)^2}{64{,}000\ AB}}$ for an extreme fiber stress of 16,000 pounds per square inch, in the slab, or

$t = \sqrt{\dfrac{3w\ (B - b)^2}{80{,}000\ AB}}$ for an extreme fiber stress of 20,000 pounds per square inch.

In these formulae—

$W$ = Total length of column in pounds.
$A$ = Width of slab in inches.
$B$ = Length of slab in inches.
$t$ = Thickness of slab in inches.
$a$ = Outside dimension of column in inches.
$b$ = Inside dimension of column in inches.




As a typical example of the above type of foundation, a column load of 1,080,000 pounds may be assumed with an allowable ground pressure of 7,500 pounds per square foot.

1,080,000 ÷ 7,500 = 144 square feet, so that a foundation 12 ft. × 12 ft. would give the required area.

Assuming the slab to be 36 inches square and the size of the column at the bottom to be 20″ × 14″, and inserting th

## Foundation Grillages

**Continued**

values in the above formulae for thickness of slab, the result is $\sqrt{\frac{3 \times 1{,}080{,}000 \times 22^2}{80{,}000 \times 36 \times 36}} = 3\frac{7}{16}''$, or say $3\frac{3}{4}''$ for thickness of slab.

### Grillage Beams

For the top tier of beams, the length of the beams would be 11 ft. The width would correspond to the size of the slab as figured above, or 3 ft. The section modulus required, using formula, $\frac{3W\,(L - n)}{32{,}000}$ would be $\frac{3 \times 1{,}080{,}000 \times 8}{32{,}000} = 810$.

By referring to the tables of beam properties, it will be seen that four 24″, 105 lb. beams, the section modulus of each being 234.3, would more than equal this requirement, the total section modulus for the four beams being 937.2.

To check these sizes of beams for shear in the web, it is necessary to get the shear in their webs at the edges of the slab. This would be $\frac{1{,}080{,}000}{11} \times \frac{11 - 3}{2} = 392{,}720\,\#$.

To resist this shear, there are four beam webs, 24″ × .625″, or 60 square inches.

$\frac{392{,}720}{60} = 6{,}045$ pounds per square inch.

For security against buckling of the webs under their direct load, there would be $\frac{1{,}080{,}000}{4 \times 36 \times .625} = 12{,}000$ pounds per square inch.

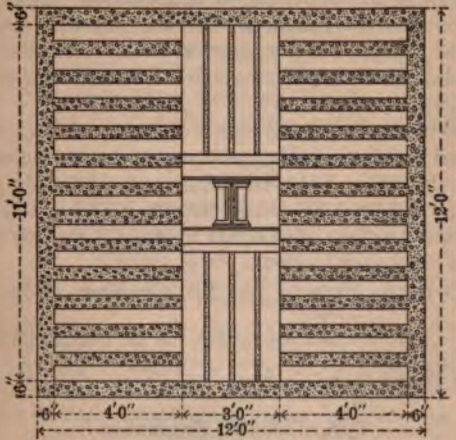
From the table on page 140, it will be noted that the safe buckling load for a 24″, 105 lb. beam is 12,350 lbs. per square inch, so the use of these beams may be considered safe.

For the bottom tier of beams, the required section modulus would be, $\frac{3 \times 1{,}080{,}000 \times (11 - 3)}{32{,}000} = 810$. This requirement would be met by the use of thirteen 15″, 50 lb. beams having a section modulus each of 64.5 or 838.5 for the entire number.

# Foundation Grillages

**Continued**

## Typical Single Foundations





END VIEW

Checking for shear and buckling in this lower tier is hardly necessary, as the net areas are manifestly in excess of the theoretical requirements.

# Foundation Grillages

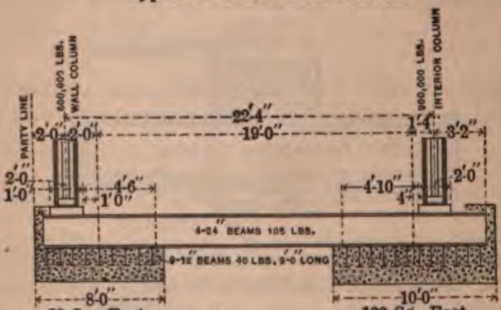
**Continued**

Where columns are to be supported close to party lines it is frequently desirable to use cantilever foundations, by which two or more foundations are combined. In the following example, the lower grillage and slabs are designed in the same manner as for the isolated footing previously mentioned. The cantilever girder would be designed as follows:

Maximum moments are over center of reaction from lower grillage and are equal to column load $\times$ distance center of column to center of grillage. In this case the wall column would cause a moment of $600{,}000 \times 24 = 14{,}400{,}000$ inch pounds. The interior column would cause a moment of $900{,}000 \times 16 = 14{,}400{,}000$ pounds, or the same as for the wall column.

Section modulus required for this cantilever girder would be $\dfrac{14{,}400{,}000}{16{,}000} = 900$, for which four 24″ 105 lb. beams, having a total modulus of 937.2, can be used.

## Typical Double Foundations




80 Sq. Feet

120 Sq. Feet


END VIEW

## Plate Girders

Plate girders are used to carry heavy loads, or for long spans where beams or rolled sections are inadequate. A plate girder consists of one or more vertical plates called web plates to which are riveted the top and bottom flanges. The function of the flanges is to take the compressive and tensile stresses developed in the outer fibers, while the web is considered to take the shearing stress. A plate girder is sometimes figured by the moment of inertia of its component parts but more frequently by considering the flange stresses as concentrated at the center of gravity of the flanges.

### Proportioning Webs

In order to avoid excessive deflection, the width of the web plate is preferably made not less than 1/15 the clear span. The thickness of web plate depends upon the shear which is greatest at the supports. This thickness must be such that the resistance to shear, computed by multiplying the area of cross-section of web by the safe unit shearing stress, shall be equal to the maximum shear on the girder.

### Stiffeners

The distribution of the shear over the web causes compression forces which are assumed to act at angles of 45 degrees with the axis of the girder in the manner indicated by figure on page 224. The web under these compression stresses is subject to failure laterally and the allowable shearing stress must, therefore, be reduced by a column formula. Either the web must be made thick enough not to exceed this allowable stress on a length of 1.414 × *ab*, which is the length on a 45 degree line between the adjacent edges of flange angles, or this unsupported length must be reduced by using stiffeners so spaced as to cut this 45 degree length down to limits which will conform to the allowable shearing stress given by the formula and to the thickness of web which it is desired to use.

A convenient diagram for determining spacing of stiffeners is shown on following page.

EXAMPLE: A plate girder composed of four 6 × 6 × ½" angles and one 42" × ⅜" web plate has a shear of 90,000 pounds near the end support. Required the spacing of stiffener angles necessary to avoid crippling of the web plate.

The area of web plate = 15.75 square inches.

Shearing stress per square inch $= \frac{90{,}000}{15.75} = 5{,}714$ pounds.

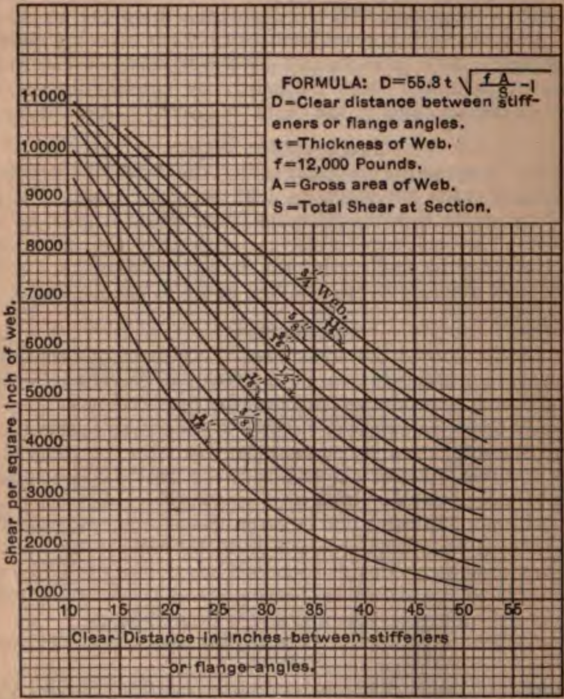
The distance between adjacent edges of flange angles = 30.5 inches.

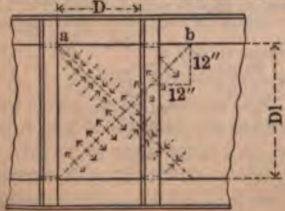
Referring to the diagram, we locate the horizontal line representing the unit shear of 5,700 pounds, and trace same to its intersection with curve line marked ⅜" and follow down along a vertical line from this point of intersection to the bottom line, where the required spacing distance of 21½" is read.

# Plate Girders

**Continued**

## Diagram for Spacing Stiffeners




When D=Dl, no stiffeners are required.

# Terra Cotta Arches

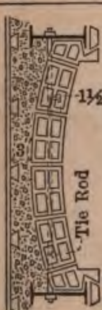
## For Floor Loads of 150 Pounds per Square Foot

FLAT ARCH

Typical Construction
Bottom of arch below bottom of beam

| Depth of Beam, Inches | Depth of Arch, Inches | Depth of Floor, Inches | Limiting Span, Feet | Approximate Weight, Pounds per Square Foot: Steel | Terra Cotta | Concrete | Flooring | Ceiling | Total |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 6 | 11 | 5¼ | 6 | 22 | 30 | 4 | 5 | 67 |
| 7 | 6 | 12 | 5¼ | 7 | 22 | 38 | 4 | 5 | 76 |
| 8 | 6 | 13 | 5¼ | 8 | 22 | 45 | 4 | 5 | 84 |
| 7 | 7 | 12 | 6 | 8 | 24 | 30 | 4 | 5 | 71 |
| 8 | 7 | 13 | 6 | 8 | 24 | 38 | 4 | 5 | 79 |
| 9 | 7 | 14 | 6 | 8 | 24 | 45 | 4 | 5 | 86 |
| 8 | 8 | 13 | 6½ | 8 | 27 | 30 | 4 | 5 | 74 |
| 9 | 8 | 14 | 6½ | 8 | 27 | 38 | 4 | 5 | 82 |
| 10 | 8 | 15 | 6½ | 8 | 27 | 45 | 4 | 5 | 89 |
| 9 | 9 | 14 | 7½ | 8 | 29 | 30 | 4 | 5 | 76 |
| 10 | 9 | 15 | 7½ | 9 | 29 | 38 | 4 | 5 | 85 |
| 12 | 9 | 17 | 7½ | 9 | 29 | 53 | 4 | 5 | 110 |
| 10 | 10 | 15 | 8 | 9 | 31 | 30 | 4 | 5 | 79 |
| 12 | 10 | 17 | 8 | 9 | 31 | 45 | 4 | 5 | 94 |
| 12 | 12 | 17 | 9½ | 10 | 35 | 30 | 4 | 5 | 84 |
| 15 | 12 | 20 | 9½ | 10 | 35 | 53 | 4 | 5 | 107 |
| 15 | 15 | 20 | 11 | 12 | 42 | 30 | 4 | 5 | 83 |

SEGMENTAL FLOOR ARCHES




Typical Construction
Top of arch level with top of Beam

| Depth of Beam, Inches | Depth of Arch, Inches | Depth of Floor, Inches | Limiting Span, Feet | Steel | Terra Cotta | Concrete | Flooring | Ceiling | Total |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 4 | Rise of Arch about ¾" per ft. of Span | 4½ | 7 | 20 | 27 | 4 | 5 | 63 |
| 7 | 4 | | 5 | 7 | 20 | 28 | 4 | 5 | 64 |
| 8 | 4 | | 5½ | 7 | 20 | 29 | 4 | 5 | 65 |
| 9 | 4 | | 6 | 8 | 20 | 30 | 4 | 5 | 67 |
| 8 | 6 | | 5 | 8 | 26 | 27 | 4 | 5 | 70 |
| 9 | 6 | | 5½ | 8 | 26 | 28 | 4 | 5 | 71 |
| 10 | 6 | | 6 | 9 | 26 | 29 | 4 | 5 | 73 |
| 12 | 6 | | 6½ | 9 | 26 | 30 | 4 | 5 | 74 |
| 10 | 8 | | 5½ | 9 | 31 | 27 | 4 | 5 | 76 |
| 12 | 8 | | 6 | 9 | 31 | 28 | 4 | 5 | 77 |
| 12 | 8 | | 6½ | 10 | 31 | 29 | 4 | 5 | 79 |
| 15 | 8 | | 7 | 10 | 31 | 30 | 4 | 5 | 80 |
| 12 | 10 | | 5¾ | 10 | 34 | 27 | 4 | 5 | 80 |
| 12 | 10 | | 6½ | 11 | 34 | 28 | 4 | 5 | 82 |
| 15 | 10 | | 7 | 11 | 34 | 29 | 4 | 5 | 83 |
| 15 | 10 | | 7½ | 12 | 34 | 30 | 4 | 5 | 85 |

For flat arches on raised skews, where the top of the arch is level with top of floor beams, deduct about 7 pounds per inch of difference between the height of the floor beam and the arch.

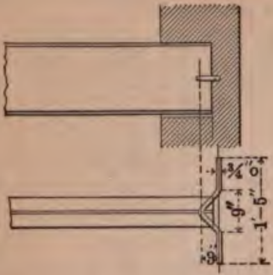
## Terra Cotta Partition, Ceiling, Roofing and Furring Blocks

| Thickness, Inches | Approximate Weight, Pounds per Square Foot: Partition | Ceiling | Roofing | Furring |
|---|---|---|---|---|
| 1½ | .................... | .................... | .................... | 9 |
| 2 | 12–14 | 12 | .................... | 10 |
| 3 | 15–17 | 20 | 20 | .................... |
| 4 | 13–19 | .................... | 22 | .................... |
| 5 | 20–22 | .................... | .................... | .................... |
| 6 | 24–26 | .................... | .................... | .................... |
| 8 | 28–33 | .................... | .................... | .................... |

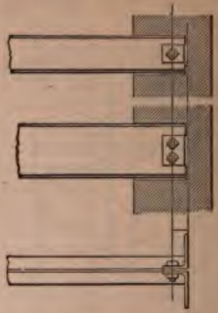
For tile partitions plastered on both sides, add about 10 pounds per square foot.

# Anchors and Tie Rods

## Government Anchors

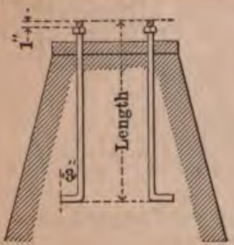



## Angle Anchors

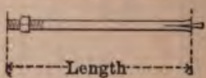


1 Bolt Anchor
Two 6″ × 4″ × 3/8″ Angles 0′ 3″ Wt. 7 lbs.
2 Bolt Anchor
Two 6″ × 4″ × 3/8″ Angles 0′ 5″ Wt. 12 lbs.
Weights include bolts

## Anchor Bolts in Foundations



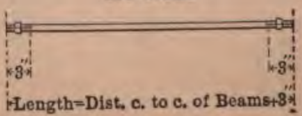

## Wedge Bolts




3/4″ Bolt 0′ 6″ lg. Appr. Wt. 1.2 lbs.
3/4″ Bolt 0′ 9″ lg. Appr. Wt. 1.6 lbs.
7/8″ Bolt 0′ 9″ lg. Appr. Wt. 2.4 lbs.
7/8″ Bolt 1′ 0″ lg. Appr. Wt. 2.9 lbs.

Weights include nuts and wedges.

## Tie Rods



## Roof Design

The character of the roof to be used on a building is a necessary corollary of the type of structure which is to be covered. On rare occasions, it will pay to put a temporary roof on a permanent structure but it would never pay to put a permanent roof on a temporary structure. A building in which the fire hazard has been reduced by a fire-resisting type of construction should have a roof equally fire-resistant from the inside and from the outside.

For a permanent building a roof should be used, the maintenance cost of which will be low, and which will compare in durability with the building itself. The durability of a roof is measured by its resistance to the effects of wind and weather. A roof for a mill or factory should also be able to resist the gases and moisture frequently produced from operations carried on beneath it. Ample provision should also be made for drainage and it is generally preferable to drain a roof to the outside rather than to drain it to interior points.

The loads to be assumed in designing roofs very properly vary with the location. In regions of heavy snows, and with roofs whose slopes are so flat that snow would be retained, a minimum load per horizontal square foot would probably be about 25 pounds. This should hold for all slopes up to approximately 20 degrees.

For steeper slopes than this, the load maybe reduced in the ratio of about one pound for each degree that the slope is increased up to 45 degrees. For roofs of steeper pitch than this, it is hardly necessary to consider snow load as little snow will rest on a roof of this pitch.

Wind loads, on the other hand, should be assumed as increasing with the pitch of the roof, in place of decreasing, as would be the case with snow loads, and a provision for horizontal wind force of 40 pounds per square foot of vertical surface in exposed locations would in most cases be ample.

For inclined surfaces, it is only necessary to take the component of this wind pressure that is normal to the surface being considered, for which the formula $Pn = P (\sin a) 1.84 \cos a - l$; in which $P$ equals direct horizontal pressure, $Pn$ equals the pressure normal to

## Roof Design

**Continued**

the sloping surface and *a* the angle of the sloping surface with the horizontal. On an assumption of 30 pounds per square foot, this formula works out to give a normal pressure as per the following table.

| Slope $a°$ | Pressure, Pn, per Square Foot, Pounds | Slope $a°$ | Pressure, Pn, per Square Foot, Pounds | Slope $a°$ | Pressure, Pn, per Square Foot, Pounds | Slope $a°$ | Pressure, Pn, per Square Foot, Pounds |
|---|---|---|---|---|---|---|---|
| 5 | 3.9 | 20 | 13.8 | 35 | 22.6 | 50 | 28.6 |
| 10 | 7.2 | 25 | 17.0 | 40 | 25.0 | 55 | 29.6 |
| 15 | 10.7 | 30 | 19.9 | 45 | 27.0 | 60 | 30.0 |

It will be noted that for slopes making an angle of over 60 degrees with the horizontal, the pressure normal to the slope is that of a vertical surface.

For climates corresponding to that of our northern states, and where the local building laws do not fix the roof loads to be used, good practice indicates that for roofs where the clear span is not over 100 feet, provision for a total load about as follows is right.

| Roof Covering | | Roof Load per Square Foot, Pounds |
|---|---|---|
| Gravel or Composition Roofing | on boards, flat slope, 1 to 6 or less | 50 |
| | on boards, steep slope, more than 1 to 6 | 45 |
| | on 3 inch flat tile or cinder concrete | 60 |
| Corrugated sheeting on boards or purlins | | 40 |
| Slate | on boards or purlins | 50 |
| | on 3 inch flat tile or cinder concrete | 65 |
| Tile on steel purlins | | 55 |
| Glass | | 45 |

In more southern latitudes where snow is not likely to occur, these loads can be safely reduced about 10 pounds per square foot.

For protection against weather the use of tin, gravel, asphalt or similar composition roofing is good for flat roofs, as is slate, tin and tile for steeper pitched roofs. Mill and factory buildings have for years been satisfactorily covered with corrugated sheets.

## Roof Design

**Continued**

The first mentioned above require sheathing to properly support them on rafters or purlins. Corrugated sheets are sometimes placed on sheathing but more frequently are directly attached to the roof purlins.

The weights of these various weather-proofing materials run approximately as follows:

| Roofing Material | Weight per Square Foot, Pounds |
|---|---|
| Copper, No. 22 B. W. G. | 1¼ |
| Corrugated galvanized iron, No. 20 B. W. G. | 2¼ |
| Corrugated galvanized iron, No. 26 B. W. G. | 1¼ |
| Felt, 2 layers | ½ |
| Felt and asphalt or coal-tar | 2 |
| Glass, ⅛ inch thick | 1¾ |
| Lath and plaster ceiling | 6–8 |
| Lead, ⅛ inch thick | 7½ |
| Mackite, 1 inch thick, with plaster | 10 |
| Sheathing, hemlock, 1 inch thick | 2 |
| Sheathing, white pine, spruce, 1 inch thick | 2¼–2½ |
| Sheathing, yellow pine, 1 inch thick | 3½ |
| Shingles, 6x18 inches, 6 inches to weather | 2 |
| Skylight, glass 3/16 to ½ inch, including frame | 4–10 |
| Slag roof, 4-ply, with cement and sand | 4 |
| Slate, ⅛ inch thick, 3 inch double lap | 4½ |
| Slate, 3/16 inch thick, 3 inch double lap | 6¾ |
| Terneplate, IC | ½ |
| Terneplate, IX | ⅝ |
| Tiles (plain), 10½x6¼x⅝ inches, 5¼ inches to weather | 18 |
| Tiles (Spanish), 14½x10½ inches, 7¼ inches to weather | 8½ |
| Zinc, No. 20 B. W. G. | 1½ |

Where flat roofs are used on spans up to 45 feet, it is frequently economical to carry the roof on beams. This is not possible where the spans exceed this limit and it then becomes necessary to use trusses, the total load on the roof being usually considered as uniformly distributed, although, with steep pitched roofs, it will be necessary to make a special analysis of the stresses due to the unequal loading of the trusses from wind pressure.

In placing purlins on roof trusses, it is always advisable to place them on the panel points of the truss, as this obviates local stresses in the chords due to bending, which will always occur when purlins are placed other than at panel points.

## Roof Design

**Continued**

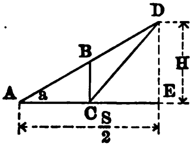
The maximum spacing of purlins will depend on the strength of the sheathing or corrugated sheets used for the direct support of the roof. With corrugated sheets the usual spacing is about 5 feet, while with 2″ sheathing it is frequently possible to get 8 to 10 feet spacing of purlins.

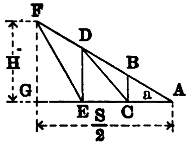
The approximate weight of roof trusses which it is frequently convenient to know for purposes of preliminary design, can be determined by the formula $\frac{L}{20} + \frac{12}{l}$ = weight of truss in pounds per horizontal square foot. In this formula, $L$ equals the span, and $l$ equals the distance center to center of trusses.

This is based on 40 pounds per square foot total load and where loads exceed this amount, the weight of the truss can be increased in direct proportion as the load exceeds this amount.

# Trusses

## Formulae for Stresses and Coefficients




$$n = \frac{S}{H} = 2 \cot a$$

### PRATT TRUSS—4 Panels

| Member | Stress | Length |
|---|---|---|
| AB, BD | $+\frac{3}{4}\sqrt{n^2+4} \times W$ | $\frac{1}{4} S \sec a$ |
| AC | $-\frac{3}{4} n \times W$ | $\frac{1}{4} S$ |
| CE | $-\frac{1}{2} n \times W$ | $\frac{1}{2} S$ |
| BC | $+1 \times W$ | $\frac{1}{2} H$ |
| CD | $-\frac{1}{4}\sqrt{n^2+16} \times W$ | $\frac{1}{4}\sqrt{S^2+16H^2}$ |

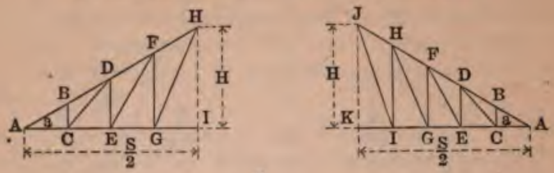
### PRATT TRUSS—6 Panels

| Member | Stress | Length |
|---|---|---|
| AB, BD | $+5/4\sqrt{n^2+4} \times W$ | $\frac{1}{6} S \sec a$ |
| DF | $+\sqrt{n^2+4} \times W$ | $\frac{1}{6} S \sec a$ |
| AC | $-5/4\, n \times W$ | $\frac{1}{6} S$ |
| CE | $-n \times W$ | $\frac{1}{6} S$ |
| EG | $-\frac{3}{4} n \times W$ | $\frac{1}{3} S$ |
| BC | $+1 \times W$ | $\frac{1}{3} H$ |
| DE | $+3/2 \times W$ | $\frac{2}{3} H$ |
| CD | $-\frac{1}{4}\sqrt{n^2+16} \times W$ | $\frac{1}{6}\sqrt{S^2+16H^2}$ |
| EF | $-\frac{1}{4}\sqrt{n^2+32} \times W$ | $\frac{1}{6}\sqrt{S^2+36H^2}$ |

# Trusses

### Continued

## Formulae for Stresses and Coefficients



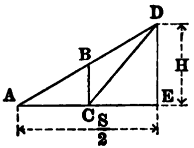

$$n = \frac{S}{H} = 2 \cot a$$

PRATT TRUSS—8 Panels

| Member | Stress | Length |
|---|---|---|
| AB, BD | $+7/4 \sqrt{n^2+4} \times W$ | $\frac{1}{8} S \sec a$ |
| DF | $+3/2 \sqrt{n^2+4} \times W$ | $\frac{1}{8} S \sec a$ |
| FH | $+5/4 \sqrt{n^2+4} \times W$ | $\frac{1}{8} S \sec a$ |
| AC | $-7/4\, n \times W$ | $\frac{1}{8} S$ |
| CE | $-3/2\, n \times W$ | $\frac{1}{8} S$ |
| EG | $-5/4\, n \times W$ | $\frac{1}{8} S$ |
| GI | $-\; n \times W$ | $\frac{1}{4} S$ |
| BC | $+1 \times W$ | $\frac{1}{4} H$ |
| DE | $+3/2 \times W$ | $\frac{1}{2} H$ |
| FG | $+2 \times W$ | $\frac{3}{4} H$ |
| CD | $-\frac{1}{4} \sqrt{n^2+16} \times W$ | $\frac{1}{8} \sqrt{S^2+16H^2}$ |
| EF | $-\frac{1}{4} \sqrt{n^2+36} \times W$ | $\frac{1}{8} \sqrt{S^2+36H^2}$ |
| GH | $-\frac{1}{4} \sqrt{n^2+64} \times W$ | $\frac{1}{8} \sqrt{S^2+64H^2}$ |

PRATT TRUSS—10 Panels

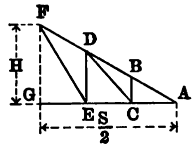
| Member | Stress | Length |
|---|---|---|
| AB, BD | $+9/4 \sqrt{n^2+4} \times W$ | $1/10\, S \sec a$ |
| DF | $+2 \sqrt{n^2+4} \times W$ | $1/10\, S \sec a$ |
| FH | $+7/4 \sqrt{n^2+4} \times W$ | $1/10\, S \sec a$ |
| HJ | $+3/2 \sqrt{n^2+4} \times W$ | $1/10\, S \sec a$ |
| AC | $-9/4\, n \times W$ | $1/10\, S$ |
| CE | $-\;2\, n \times W$ | $1/10\, S$ |
| EG | $-7/4\, n \times W$ | $1/10\, S$ |
| GI | $-3/2\, n \times W$ | $1/10\, S$ |
| IK | $-5/4\, n \times W$ | $1/5\, S$ |
| BC | $+1 \times W$ | $1/5\, H$ |
| DE | $+3/2 \times W$ | $2/5\, H$ |
| FG | $+2 \times W$ | $3/5\, H$ |
| HI | $+5/2 \times W$ | $4/5\, H$ |
| CD | $-\frac{1}{4} \sqrt{n^2+16} \times W$ | $1/10 \sqrt{S^2+16H^2}$ |
| EF | $-\frac{1}{4} \sqrt{n^2+32} \times W$ | $1/10 \sqrt{S^2+36H^2}$ |
| GH | $-\frac{1}{4} \sqrt{n^2+64} \times W$ | $1/10 \sqrt{S^2+64H^2}$ |
| IJ | $-\frac{1}{4} \sqrt{n^2+100} \times W$ | $1/10 \sqrt{S^2+100H^2}$ |




# Trusses

## Continued

## Coefficients of Stresses



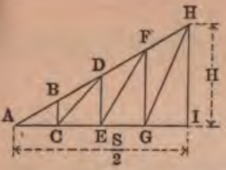

| Member | n = Span ÷ Height = 2 cot a | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
| AB, BD | 2.70 | 2.98 | 3.00 | 3.35 | 3.90 | 4.04 | 4.74 |
| AC | 2.25 | 2.57 | 2.60 | 3.00 | 3.60 | 3.75 | 4.50 |
| CE | 1.50 | 1.71 | 1.73 | 2.00 | 2.40 | 2.50 | 3.00 |
| BC | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| CD | 1.25 | 1.32 | 1.32 | 1.41 | 1.56 | 1.60 | 1.80 |

| Member | n = Span ÷ Height = 2 cot a | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
| AB, BD | 4.51 | 4.96 | 5.00 | 5.59 | 6.50 | 6.73 | 7.91 |
| DF | 3.61 | 3.97 | 4.00 | 4.47 | 5.20 | 5.39 | 6.32 |
| AC | 3.75 | 4.29 | 4.33 | 5.00 | 6.00 | 6.25 | 7.50 |
| CE | 3.00 | 3.43 | 3.46 | 4.00 | 4.80 | 5.00 | 6.00 |
| EG | 2.25 | 2.57 | 2.60 | 3.00 | 3.60 | 3.75 | 4.50 |
| BC | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DF | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| CD | 1.25 | 1.32 | 1.32 | 1.41 | 1.56 | 1.60 | 1.80 |
| EF | 1.68 | 1.73 | 1.73 | 1.80 | 1.92 | 1.95 | 2.12 |

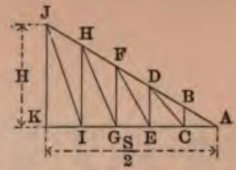
# Trusses

**Continued**

## Coefficients of Stresses




| Member | n = Span ÷ Height = 2 cot a: 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| AB, BD | 6.31 | 6.95 | 7.00 | 7.83 | 9.10 | 9.42 | 11.07 |
| DF | 5.41 | 5.95 | 6.00 | 6.71 | 7.80 | 8.08 | 9.49 |
| FH | 4.51 | 4.97 | 5.00 | 5.59 | 6.50 | 6.73 | 7.91 |
| AC | 5.25 | 6.00 | 6.06 | 7.00 | 8.40 | 8.75 | 10.50 |
| CE | 4.50 | 5.14 | 5.20 | 6.00 | 7.20 | 7.50 | 9.00 |
| EG | 3.75 | 4.29 | 4.33 | 5.00 | 6.00 | 6.25 | 7.50 |
| GI | 3.00 | 3.43 | 3.46 | 4.00 | 4.80 | 5.00 | 6.00 |
| BC | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DE | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| FG | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| CD | 1.25 | 1.32 | 1.32 | 1.41 | 1.56 | 1.60 | 1.80 |
| EF | 1.68 | 1.73 | 1.73 | 1.80 | 1.92 | 1.95 | 2.12 |
| GH | 2.14 | 2.18 | 2.18 | 2.24 | 2.33 | 2.36 | 2.50 |

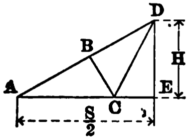


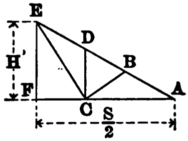

| Member | n = Span ÷ Height = 2 cot a: 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| AB, BD | 8.11 | 8.93 | 9.00 | 10.06 | 11.70 | 12.12 | 14.23 |
| DF | 7.21 | 7.94 | 8.00 | 8.94 | 10.40 | 10.77 | 12.65 |
| FH | 6.31 | 6.95 | 7.00 | 7.83 | 9.10 | 9.42 | 11.07 |
| HJ | 5.41 | 5.95 | 6.00 | 6.71 | 7.80 | 8.08 | 9.49 |
| AC | 6.75 | 7.71 | 7.79 | 9.00 | 10.80 | 11.25 | 13.50 |
| CE | 6.00 | 6.86 | 6.93 | 8.00 | 9.60 | 10.00 | 12.00 |
| EG | 5.25 | 6.00 | 6.06 | 7.00 | 8.40 | 8.75 | 10.50 |
| GI | 4.50 | 5.14 | 5.20 | 6.00 | 7.20 | 7.50 | 9.00 |
| IK | 3.75 | 4.29 | 4.33 | 5.00 | 6.00 | 6.25 | 7.50 |
| BC | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DE | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| FG | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| HI | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| CD | 1.25 | 1.32 | 1.32 | 1.41 | 1.56 | 1.60 | 1.80 |
| EF | 1.68 | 1.73 | 1.73 | 1.80 | 1.92 | 1.95 | 2.12 |
| GH | 2.14 | 2.18 | 2.18 | 2.24 | 2.33 | 2.36 | 2.50 |
| IJ | 2.61 | 2.64 | 2.65 | 2.69 | 2.77 | 2.80 | 2.92 |

# Trusses

**Continued**

## Formulae for Stresses and Lengths




$$n = \frac{S}{H} = 2 \cot a$$

### SIMPLE FINK TRUSS

| Member | Stress | Length |
|---|---|---|
| AB | $+\frac{3}{4}\sqrt{n^2+4} \times W$ | $\frac{1}{4} L \sec a$ |
| BD | $+\frac{1}{\sqrt{n^2+4}}\left(\frac{3}{4} n^2 + 1\right) \times W$ | $\frac{1}{4} L \sec a$ |
| AC | $-\frac{3}{4} n \times W$ | $\frac{1}{4} L \sec^2 a$ |
| CE | $-\frac{1}{2} n \times W$ | $L \left(1 - \frac{1}{2} \sec^2 a\right)$ |
| BC | $+\frac{n}{\sqrt{n^2+4}} \times W$ | $\frac{1}{4} L \sec a \tan a$ |
| CD | $-\frac{1}{4} n \times W$ | $\frac{1}{4} L \sec^2 a$ |

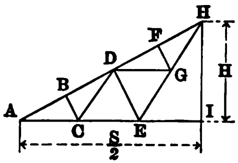
### SIMPLE FAN TRUSS

| Member | Stress | Length |
|---|---|---|
| AB | $+\frac{1}{\sqrt{n^2+4}}\left(5/4\, n^2 + 5\right) \times W$ | $\frac{1}{6} L \sec a$ |
| BD | $+\frac{1}{2\sqrt{n^2+4}}\, 13/6\, (n^2 + 6) \times W$ | $\frac{1}{6} L \sec a$ |
| DE | $+\frac{1}{\sqrt{n^2+4}}\left(5/4\, n^2 + 1\right) \times W$ | $\frac{1}{6} L \sec a$ |
| AC | $-5/4\, n \times W$ | $\frac{1}{4} L \sec^2 a$ |
| CF | $-\frac{3}{4}\, n \times W$ | $L \left(1 - \frac{1}{2} \sec^2 a\right)$ |
| BC, CD | $+n \sqrt{n^4 + 40 n^2 + 144} \times W$ | $+\frac{1}{4} L \sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$ |
| CE | $-\frac{1}{2} n \times W$ | $\frac{1}{4} L \sec^2 a$ |

# Trusses

**Continued**

## Formulae for Stresses and Lengths




$$n = \frac{S}{H} = 2 \cot a$$

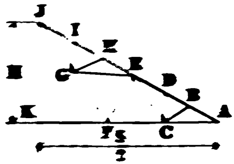
### COMPOUND FINK TRUSS

| Member | Stress | Length |
|---|---|---|
| AB | $+7/4\ \sqrt{n^2+4} \times W$ | $\frac{1}{8} L \sec a$ |
| BD | $+\frac{1}{\sqrt{n^2+4}}(7/4\ n^2+5) \times W$ | $\frac{1}{8} L \sec a$ |
| DF | $+\frac{1}{\sqrt{n^2+4}}(7/4\ n^2+3) \times W$ | $\frac{1}{8} L \sec a$ |
| FH | $+\frac{1}{\sqrt{n^2+4}}(7/4\ n^2+1) \times W$ | $\frac{1}{8} L \sec a$ |
| AC | $-7/4\ n \times W$ | $\frac{1}{8} L \sec^2 a$ |
| CE | $-3/2\ n \times W$ | $\frac{1}{8} L \sec^2 a$ |
| EI | $-n \times W$ | $L(1-\frac{1}{2}\sec^2 a)$ |
| BC, FG | $+\frac{n}{\sqrt{n^2+4}} \times W$ | $\frac{1}{8} L \sec a \tan a$ |
| DE | $+\frac{2n}{\sqrt{n^2+4}} \times W$ | $\frac{1}{4} L \sec a \tan a$ |
| CD, DG | $-\frac{1}{4} n \times W$ | $\frac{1}{8} L \sec^2 a$ |
| EG | $-\frac{1}{2} n \times W$ | $\frac{1}{8} L \sec^2 a$ |
| GH | $-\frac{3}{4} n \times W$ | $\frac{1}{8} L \sec^2 a$ |

# Trusses

## Continued

## Formulae for Stresses and Lengths




$$n = \frac{S}{H} = 2 \cot a$$

### COMPOUND FAN TRUSS

| Member | Stress | Length |
|---|---|---|
| AB | $+\frac{1}{\sqrt{n^2+4}}(11/4\, n^2 + 11) \times W$ | $1/12\, L \sec a$ |
| BD | $+\frac{1}{\sqrt{n^2+4}}(31/12\, n^2 + 9) \times W$ | $1/12\, L \sec a$ |
| DE | $+\frac{1}{\sqrt{n^2+4}}(11/4\, n^2 + 7) \times W$ | $1/12\, L \sec a$ |
| EH | $+\frac{1}{\sqrt{n^2+4}}(11/4\, n^2 + 5) \times W$ | $1/12\, L \sec a$ |
| HI | $+\frac{1}{\sqrt{n^2+4}}(31/12\, n^2 + 3) \times W$ | $1/12\, L \sec a$ |
| IJ | $+\frac{1}{\sqrt{n^2+4}}(11/4\, n^2 + 1) \times W$ | $1/12\, L \sec a$ |
| AC | $-11/4\, n \times W$ | $1/8\, L \sec^2 a$ |
| CF | $-9/4\, n \times W$ | $1/8\, L \sec^2 a$ |
| FK | $-3/2\, n \times W$ | $L(1 - 1/2 \sec^2 a)$ |
| BC, CD, GH, GI | $+\frac{n\sqrt{n^4 + 40 n^2 + 144}}{6(n^2+4)} \times W$ | $1/8\, L \sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$ |
| EF | $+\frac{3n}{\sqrt{n^2+4}} \times W$ | $1/4\, L \sec a \tan a$ |
| CE, EG | $-1/2\, n \times W$ | $1/8\, L \sec^2 a$ |
| FG | $-1/4\, n \times W$ | $1/8\, L \sec^2 a$ |
| GJ | $-5/4\, n \times W$ | $1/8\, L \sec^2 a$ |

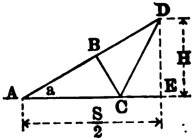
# Trusses

**Continued**

## Coefficients for Calculating Strength of Truss Members

Continued from pages 236 and 237

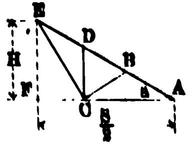
| Values of $n$ | 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Values of $a$ | 33°41′24″ | 30°15′23″ | 30° | 26°33′54″ | 22°37′12″ | 21° 48′ 5″ | 18° 26′ 6″ |
| Sec $a$ | 1.2018 | 1.1577 | 1.1547 | 1.1180 | 1.0833 | 1.0770 | 1.0541 |
| Sec² $a$ | 1.4444 | 1.3403 | 1.3333 | 1.2500 | 1.1736 | 1.1600 | 1.1111 |
| Sec $a$ tan $a$ | 0.8012 | 0.6753 | 0.6667 | 0.5590 | 0.4514 | 0.4308 | 0.3514 |
| $\sqrt{\frac{\sec^2 a}{9} + \sec^2 a \tan^2 a}$ | 0.8958 | 0.7778 | 0.7698 | 0.6718 | 0.5781 | 0.5608 | 0.4969 |




# Trusses

## Continued

## Coefficients of Stresses



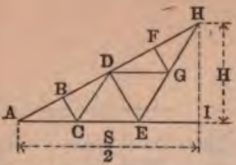

| Member | n = Span ÷ Height = 2 cot a | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | $\frac{24}{7}$ | 2 cot 30° | 4 | $\frac{24}{5}$ | 5 | 6 |
| AB | 2.70 | 2.98 | 3.00 | 3.35 | 3.90 | 4.04 | 4.74 |
| BD | 2.15 | 2.47 | 2.50 | 2.91 | 3.52 | 3.67 | 4.43 |
| AC | 2.25 | 2.57 | 2.60 | 3.00 | 3.60 | 3.75 | 4.50 |
| CE | 1.50 | 1.71 | 1.73 | 2.00 | 2.40 | 2.50 | 3.00 |
| BC | 0.83 | 0.86 | 0.87 | 0.89 | 0.92 | 0.93 | 0.95 |
| CD | 0.75 | 0.86 | 0.87 | 1.00 | 1.20 | 1.25 | 1.50 |

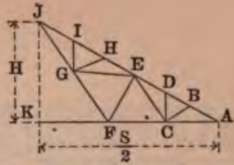
| Member | n = Span ÷ Height = 2 cot a | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3 | $\frac{24}{7}$ | 2 cot 30° | 4 | $\frac{24}{5}$ | 5 | 6 |
| AB | 4.51 | 4.98 | 5.00 | 5.50 | 6.50 | 6.73 | 7.01 |
| BD | 3.54 | 3.96 | 4.00 | 4.55 | 5.38 | 5.80 | 6.04 |
| DE | 3.40 | 3.95 | 4.00 | 4.70 | 5.73 | 6.00 | 7.27 |
| AC | 3.75 | 4.30 | 4.33 | 5.00 | 6.00 | 6.25 | 7.50 |
| CF | 2.25 | 2.57 | 2.00 | 3.00 | 3.00 | 3.75 | 4.50 |
| CB, CD | 0.93 | 0.99 | 1.00 | 1.08 | 1.18 | 1.21 | 1.34 |
| CE | 1.50 | 1.71 | 1.73 | 2.00 | 2.40 | 2.50 | 3.00 |

# Trusses

### Continued

## Coefficients of Stresses




| Member | n = Span ÷ Height = 2 cot a: 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| AB | 6.31 | 6.95 | 7.00 | 7.83 | 9.10 | 9.42 | 11.07 |
| BD | 5.76 | 6.44 | 6.50 | 7.38 | 8.72 | 9.05 | 10.75 |
| DF | 5.20 | 5.94 | 6.00 | 6.93 | 8.33 | 8.68 | 10.43 |
| FH | 4.65 | 5.43 | 5.50 | 6.48 | 7.95 | 8.31 | 10.12 |
| AC | 5.25 | 6.00 | 6.07 | 7.00 | 8.40 | 8.75 | 10.50 |
| CE | 4.50 | 5.14 | 5.20 | 6.00 | 7.20 | 7.50 | 9.00 |
| CI | 3.00 | 3.43 | 3.46 | 4.00 | 4.80 | 5.00 | 6.00 |
| BC, FG | 0.83 | 0.86 | 0.87 | 0.89 | 0.92 | 0.93 | 0.95 |
| DE | 1.66 | 1.73 | 1.73 | 1.79 | 1.85 | 1.86 | 1.90 |
| CD, DG | 0.75 | 0.86 | 0.87 | 1.00 | 1.20 | 1.25 | 1.50 |
| EG | 1.50 | 1.71 | 1.73 | 2.00 | 2.40 | 2.50 | 3.00 |
| GH | 2.25 | 2.57 | 2.60 | 3.00 | 3.60 | 3.75 | 4.50 |

| Member | n = Span ÷ Height = 2 cot a: 3 | 24/7 | 2 cot 30° | 4 | 24/5 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| AB | 9.92 | 10.91 | 11.00 | 12.30 | 14.30 | 14.81 | 17.39 |
| BD | 8.95 | 9.91 | 10.00 | 11.25 | 13.18 | 13.66 | 16.13 |
| DE | 8.81 | 9.91 | 10.00 | 11.40 | 13.53 | 14.07 | 16.76 |
| EH | 8.25 | 9.40 | 9.50 | 10.96 | 13.15 | 13.70 | 16.44 |
| HI | 7.28 | 8.41 | 8.50 | 9.91 | 12.02 | 12.55 | 15.18 |
| IJ | 7.14 | 8.40 | 8.50 | 10.06 | 12.38 | 12.95 | 15.93 |
| AC | 8.25 | 9.43 | 9.53 | 11.00 | 13.20 | 13.75 | 16.50 |
| CF | 6.75 | 7.71 | 7.79 | 9.00 | 10.80 | 11.25 | 13.50 |
| FK | 4.50 | 5.14 | 5.20 | 6.00 | 7.20 | 7.50 | 9.00 |
| BC, DC, GH, GI | 0.93 | 0.99 | 1.00 | 1.08 | 1.18 | 1.21 | 1.34 |
| EF | 2.50 | 2.59 | 2.60 | 2.68 | 2.77 | 2.79 | 2.85 |
| CE, EG | 1.50 | 1.71 | 1.73 | 2.00 | 2.40 | 2.50 | 3.00 |
| FG | 2.25 | 2.57 | 2.60 | 3.00 | 3.60 | 3.75 | 4.50 |
| GJ | 3.75 | 4.29 | 4.33 | 5.00 | 6.00 | 6.25 | 7.50 |

# Compression Formulae

## Comparison of Allowable Unit Stresses in Pounds per Squar

| $\frac{l}{r}$ | A.R.E. Assn. Chicago Used by J. & L. S. Co. $16000-70\frac{l}{r}$ 14000 Max. | Gordon $\frac{12500}{1+\frac{l^2}{36000 r^2}}$ | New York $15200-58\frac{l}{r}$ | Philadelphia $\frac{16250}{1+\frac{l^2}{11000 r^2}}$ | Boston $\frac{16000}{1+\frac{l^2}{20000 r^2}}$ | Pitt 1900 1300 |
|---|---|---|---|---|---|---|
| 0 | 14000 | 12500 | 15200 | 16250 | 16000 | 13 |
| 5 | 14000 | 12490 | 14910 | 16215 | 15980 | 13 |
| 10 | 14000 | 12460 | 14620 | 16100 | 15920 | 13 |
| 15 | 14000 | 12420 | 14330 | 15925 | 15820 | 13 |
| 20 | 14000 | 12365 | 14040 | 15680 | 15690 | 13 |
| 25 | 14000 | 12285 | 13750 | 15375 | 15515 | 13 |
| 30 | 13900 | 12195 | 13460 | 15020 | 15310 | 13 |
| 35 | 13550 | 12090 | 13170 | 14620 | 15075 | 13 |
| 40 | 13200 | 11970 | 12880 | 14185 | 14815 | 13 |
| 45 | 12850 | 11835 | 12590 | 13725 | 14530 | 13 |
| 50 | 12500 | 11690 | 12300 | 13240 | 14220 | 13 |
| 55 | 12150 | 11530 | 12010 | 12745 | 13900 | 13 |
| 60 | 11800 | 11365 | 11720 | 12240 | 13560 | 13 |
| 65 | 11450 | 11185 | 11430 | 11740 | 13210 | 12 |
| 70 | 11100 | 11000 | 11140 | 11240 | 12850 | 12 |
| 75 | 10750 | 10810 | 10850 | 10750 | 12490 | 11 |
| 80 | 10400 | 10615 | 10560 | 10275 | 12120 | 11 |
| 85 | 10050 | 10410 | 10270 | 9810 | 11755 | 10 |
| 90 | 9700 | 10205 | 9980 | 9360 | 11390 | 10 |
| 95 | 9350 | 9995 | 9690 | 8930 | 11025 | 9 |
| 100 | 9000 | 9785 | 9400 | 8510 | 10670 | 9 |
| 105 | 8650 | 9570 | 9110 | 8115 | 10315 | 8 |
| 110 | 8300 | 9355 | 8820 | 7740 | 9970 | 8 |
| 115 | 7950 | 9140 | 8530 | 7380 | 9630 | 7 |
| 120 | 7600 | 8930 | 8240 | 7035 | 9300 | 7 |
| 125 | 7250 | 8715 | ......... | 6715 | ......... | 6 |

EXPLANATION OF HEADINGS

J. & L. S. Co.—Jones & Laughlin Steel Company.
A. R. E. Assn.—American Railway Engineering Association.
Cities—Building Laws.
Unit stresses given below heavy line are not found by formula given.

Continued on next page.

# Compression Formulae

**Continued**

## Comparison of Allowable Unit Stresses in Pounds Per Square Inch

| $\frac{l}{r}$ | A.R.E. Assn. Chicago Used by J. & L. S. Co. | Gordon | New York | Philadelphia | Boston | Pittsburgh |
|---|---|---|---|---|---|---|
| | $16000-70\frac{l}{r}$ 14000 Max. | $\frac{12500}{1+\frac{l^2}{36000r^2}}$ | $15200-58\frac{l}{r}$ | $\frac{16250}{1+\frac{l^2}{11000r^2}}$ | $\frac{16000}{1+\frac{l^2}{20000r^2}}$ | $19000-100\frac{l}{r}$ 13000 Max. |
| 130 | 6900 | 8510 | .......... | 6405 | .......... | 6500 |
| 135 | 6550 | 8300 | .......... | 6115 | .......... | 6250 |
| 140 | 6200 | 8095 | .......... | 5840 | .......... | 6000 |
| 145 | 5850 | 7890 | .......... | .......... | .......... | 5750 |
| 150 | 5500 | 7690 | .......... | .......... | .......... | 5500 |
| 155 | .......... | 7495 | .......... | .......... | .......... | .......... |
| 160 | .......... | 7305 | .......... | .......... | .......... | .......... |
| 165 | .......... | 7120 | .......... | .......... | .......... | .......... |
| 170 | .......... | 6935 | .......... | .......... | .......... | .......... |
| 175 | .......... | 6755 | .......... | .......... | .......... | .......... |
| 180 | .......... | 6580 | .......... | .......... | .......... | .......... |
| 185 | .......... | 6410 | .......... | .......... | .......... | .......... |
| 190 | .......... | 6240 | .......... | .......... | .......... | .......... |
| 195 | .......... | 6080 | .......... | .......... | .......... | .......... |
| 200 | .......... | 5920 | .......... | .......... | .......... | .......... |

EXPLANATION OF HEADINGS

J. & L. S. Co.—Jones & Laughlin Steel Company.
A. R. E. Assn.—American Railway Engineering Association.
Cities—Building Laws.
Unit stresses given below heavy line are not found by formula given.

# Floors and Roofs

## Minimum Live Loads, Pounds per Square Foot

### By Building Laws of Various Cities

| Kind of Building | Boston, 1912 | New York, 1906 | Philadelphia, 1913 | Baltimore, 1908 | Pittsburgh, 1913 | Cleveland, 1911 | Chicago, 1911 | St. Louis, 1910 | San Francisco, 1910 |
|---|---|---|---|---|---|---|---|---|---|
| Apartments | 50 | 60 | 70 | 60 | 50 | 50 | 40 | 60 | 60 |
| Public Rooms* and Halls | 100 | .... | .... | .... | .... | 80 | .... | .... | .... |
| Assembly Halls | 125 | 90 | 120 | .... | 125 | 100 | .... | 100 | 125 |
| Fixed Seat Auditoriums | .... | .... | .... | 75 | †125 | 80 | 100 | .... | 75 |
| Movable Seat Auditoriums | .... | .... | .... | 125 | .... | 100 | 100 | .... | 125 |
| Churches | .... | 90 | .... | 75 | 125 | .... | 100 | .... | 125 |
| Dance Halls | 200 | .... | .... | .... | 150 | 150 | 100 | .... | .... |
| Drill Rooms | 200 | .... | .... | .... | 150 | .... | .... | .... | .... |
| Riding Schools | 200 | .... | .... | .... | 150 | .... | .... | .... | .... |
| Theaters | .... | 90 | .... | 75 | 125 | .... | 100 | .... | 125 |
| Dwellings | 50 | 60 | 70 | 60 | 50 | 40 | 40 | 60 | 60 |
| Public Rooms* | 100 | .... | .... | .... | .... | .... | .... | .... | .... |
| Hotels | 50 | 60 | 70 | 60 | 70 | 50 | 50 | 60 | 60 |
| First Floors | .... | .... | .... | .... | .... | .... | .... | 100 | .... |
| Corridors | .... | .... | .... | .... | .... | 80 | .... | .... | .... |
| Office Floors | 100 | .... | .... | .... | .... | 80 | .... | .... | .... |
| Public Rooms* | 100 | .... | .... | .... | .... | .... | .... | .... | .... |
| Manufacturing | 125 | 120 | 120 | 125 | 125 | .... | 100 | .... | 125 |
| Light Factories | .... | 120 | 150 | .... | 125 | .... | .... | 150 | .... |
| Mercantile | | | | | | | | | |
| Heavy Storehouses | .... | 150 | 150 | 250 | 200 | 200 | .... | .... | 250 |
| Retail Stores | 125 | .... | 120 | 125 | 125 | 125 | 100 | 150 | 125 |
| Warehouses | 250 | 150 | 150 | .... | 200 | .... | 100 | 150 | 250 |
| Offices | 100 | 75 | 100 | 75 | 70 | 60 | 50 | 70 | 60 |
| First Floor | 100 | 150 | .... | 150 | .... | .... | .... | 150 | 150 |
| Corridors | .... | .... | .... | .... | .... | 100 | .... | .... | .... |
| Schools (Class Rooms) | 60 | 75 | .... | 75 | 70 | 60 | 40 | 100 | 75 |
| Assembly Rooms—Halls | 125 | 90 | .... | .... | 70 | 80 | 75 | .... | 125 |
| Sidewalks | .... | 300 | .... | 200 | .... | 200 | .... | .... | 150 |
| Stables—Carriage Houses | .... | 75 | .... | 100 | .... | 80 | 100 | .... | 75 |
| Area less than 500 sq. ft | .... | .... | .... | .... | .... | .... | 40 | .... | .... |
| Stairways and Landings | 70 | .... | .... | .... | .... | 80 | 100 | .... | .... |
| Fire Escapes | 70 | .... | .... | .... | .... | 80 | .... | .... | .... |
| Roofs—Flat‡ | 40 | 50 | .... | 40 | §50 | 40 | 25 | 40 | 30 |
| Horizontal Projection Steep Roofs | .... | 30 | .... | 20 | §50 | .... | 25 | .... | 20 |
| Superficial Surface | .... | .... | 30 | .... | §50 | 40 | .... | .... | .... |
| Wind Pressure | .... | 30 | ‖30 | 30 | 25 | ‖30 | 20 | 30 | 20 |

*Area greater than 500 square feet.

†First floors 200.

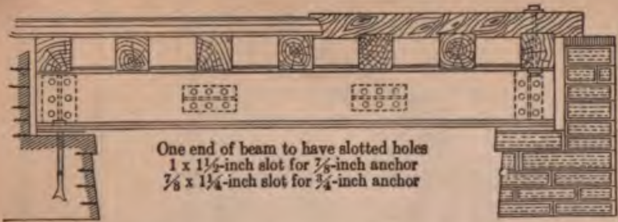
‡Slopes less than 20 degrees.

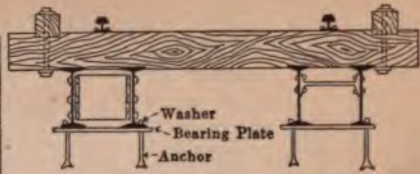
§Dead and live, except for one story steel frame buildings, corrugated iron roofs, 35 pounds.

‖High buildings, built up districts, 35 pounds; 14 stories or over, 25 pounds at tenth story, 2½ pounds less each story below.

Figures for manufacturing establishments do not include machinery.

# Details for I Beam Bridges



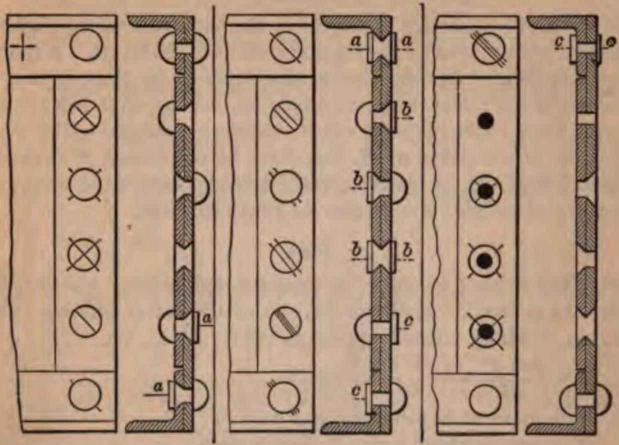

**Double**

| Size, In. | Separators, Inches | Bearing Plates, In. | Wedge and Anchors, In. | Washers, Inches |
|---|---|---|---|---|
| 24 | 20 I 65 lbs. 18 | 18x¾x32 | ⅞x12 | 2½x2½x½x¼ |
| 20 | 20 I 65 lbs. 15 | 12x¾x30 | ⅞x12 | 2½x2½x½x¼ |
| 15 | 15 I 42 lbs. 11 | 12x¾x24 | ⅞x12 | 2½x2½x½x¼ |
| 12 | 12 I 31½ lbs. 9 | 12x¾x21 | ¾x10 | 2x½x¼x2½ |
| | 10 I 25 lbs. 7 | 12x½x18 | ¾x10 | 2x½x¼x2½ |

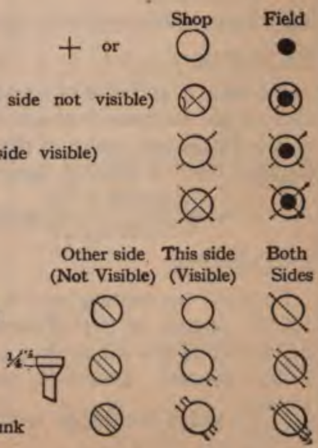
**Triple**

| Size, In. | Separators, Inches | Bearing Plates, In. | Wedge and Anchors, In. | Washers, Inches |
|---|---|---|---|---|
| 24 | 10 I 25 lbs. 18 | 18x¾x32 | ⅞x12 | 2½x2½x½x¼ |
| 20 | 10 I 25 lbs. 15 | 12x¾x32 | ⅞x12 | 2½x2½x½x¼ |
| 15 | 10 I 25 lbs. 11 | 12x¾x30 | ⅞x12 | 2½x2½x½x¼ |

# Conventional Signs for Riveting




Maximum height of heads marked $a = 1/8''$
" " " " " $b = 1/4''$
" " " " " $c = 3/8''$




Two full heads

Countersunk and chipped other side (or side not visible)

Countersunk and chipped this side (or side visible)

Countersunk and chipped both sides

Countersunk but not chipped limit 1/8 high

Flattened head 1/4" high and countersunk

Flattened head 3/4" high and not countersunk

# Stresses in Rivets and Pins

## Rivets

It is common practice to disregard the friction between plates in a riveted joint caused by the clamping effect of the rivets. A riveted joint may fail by the shearing of the rivets or by the crippling or crushing of the metal in the members around the rivet holes. The bearing value of the plates or rolled sections in addition to the shearing value of the rivets must, therefore, be considered in designing riveted joints. If the shearing value exceeds the bearing value, the latter will determine the number of rivets required.

## Pins

Pins are subject to shearing, bending and bearing stresses, but their size is mostly governed by one of the latter stresses. The following bending formula applies to pins:

$$M = \frac{f\,\pi\,d^3}{32} = \frac{f\,A\,d}{8}, \text{ in which}$$

$M$ = moment of forces for any section
$f$ = extreme fiber stress at that section
$A$ = area of section
$d$ = diameter of pin
$\pi$ = 3.14159

The forces are assumed as acting in a plane through the axis of the pin.

EXAMPLE 1.

A bolster or end shoe of a bridge carries a load of 100,000 pounds; assume the distance between points (i. e.) centers of support of bolster plates and center of post plates $2\frac{1}{2}''$. Bending moment = $50{,}000 \times 2\frac{1}{2}''$ = 125,000 inch pounds; therefore, for $f$ = 20,000;

$$d = \sqrt[3]{\frac{125{,}000 \times 32}{20{,}000 \times 3.14}} = 3.994'' \text{ or 4 inch pin.}$$

EXAMPLE 2.

Required the bearing in shoe for a 4″ pin, transmitting a load of 100,000 pounds at 20,000 pounds pressure per square inch. The bearing value of a 4 inch pin for 1 inch thickness is = $4 \times 20{,}000$ = 80,000 pounds. Therefore, the thickness of metal required = $\frac{100{,}000}{80{,}000} = 1\frac{1}{4}$ inches, or each web of the shoe must be $\frac{5}{8}$ inch including pin plates.

# Riveted Plates, Bars and Angles
## Area To Be Deducted for One Hole

| Size of Hole | Thickness of Plate, Bar or Angle | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 |
| 9/16 | .07 | .11 | .14 | .18 | .21 | .25 | .28 | .32 | .35 |
| 5/8 | .08 | .12 | .16 | .20 | .23 | .27 | .31 | .35 | .39 |
| 11/16 | .09 | .13 | .17 | .21 | .26 | .30 | .34 | .39 | .43 |
| 3/4 | .10 | .14 | .19 | .23 | .28 | .33 | .38 | .42 | .47 |
| 13/16 | .10 | .15 | .20 | .25 | .30 | .36 | .41 | .46 | .51 |
| 7/8 | .11 | .16 | .22 | .27 | .33 | .38 | .44 | .49 | .55 |
| 15/16 | .12 | .18 | .23 | .29 | .35 | .41 | .47 | .53 | .59 |
| 1 | .13 | .19 | .25 | .31 | .38 | .44 | .50 | .56 | .63 |
| 1 1/16 | .14 | .20 | .27 | .33 | .40 | .46 | .53 | .60 | .66 |
| 1 1/8 | .15 | .21 | .28 | .35 | .42 | .49 | .56 | .63 | .70 |

| Size of Hole | Thickness of Plate, Bar or Angle | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 | 1 1/16 | 1 1/8 |
| 9/16 | .39 | .42 | .46 | .49 | .53 | .56 | .60 | .63 |
| 5/8 | .43 | .47 | .51 | .55 | .59 | .63 | .66 | .70 |
| 11/16 | .47 | .52 | .56 | .60 | .64 | .69 | .73 | .77 |
| 3/4 | .52 | .56 | .61 | .66 | .70 | .75 | .80 | .84 |
| 13/16 | .56 | .61 | .66 | .71 | .76 | .81 | .86 | .91 |
| 7/8 | .60 | .66 | .71 | .77 | .82 | .88 | .93 | .98 |
| 15/16 | .64 | .70 | .76 | .82 | .88 | .94 | 1.00 | 1.05 |
| 1 | .69 | .75 | .81 | .88 | .94 | 1.00 | 1.06 | 1.13 |
| 1 1/16 | .73 | .80 | .86 | .93 | 1.00 | 1.06 | 1.13 | 1.20 |
| 1 1/8 | .77 | .84 | .91 | .98 | 1.05 | 1.13 | 1.20 | 1.27 |

# Standard Spacing and Dimensions of Rivet and Bolt Holes

## Through Flanges of Beams, Channels, Connection Angles


**Steel Beams**

| Depth in Inches | Weight per Foot, Pounds | Diameter of Bolt or Rivet, In. | Inches, A |
|---|---|---|---|
| 24 | 105. | ¾ | 4½ |
| 24 | 80. | ¾ | 4 |
| 20 | 80. | ¾ | 4 |
| 20 | 65. | ¾ | 3½ |
| 18 | 55. | ¾ | 3¼ |
| 15 | 60. | ¾ | 3¼ |
| 15 | 42. | ¾ | 3 |
| 12 | 40. | ¾ | 3 |
| 12 | 31.5 | ¾ | 2¾ |
| 10 | 25. | ¾ | 2⅝ |
| 9 | 21. | ¾ | 2½ |
| 8 | 18. | ¾ | 2¼ |
| 7 | 15. | ⅝ | 2¼ |
| 6 | 12.25 | ⅝ | 2 |
| 5 | 9.75 | ½ | 1¾ |
| 4 | 7.5 | ½ | 1½ |
| 3 | 5.5 | ⅜ | 1 7/16 |
| ... | ...... | ...... | ... |

**Steel Channels**

| Depth in Inches | Weight per Foot, Pounds | Diameter of Bolt or Rivet, In. | Inches, A |
|---|---|---|---|
| 15 | 45. | ¾ | 2¼ |
| 15 | 33. | ¾ | 1⅞ |
| 12 | 30. | ¾ | 2 |
| 12 | 20.5 | ¾ | 1¾ |
| 10 | 25. | ¾ | 2 |
| 10 | 15. | ¾ | 1½ |
| 9 | 20. | ¾ | 1¾ |
| 9 | 13.25 | ¾ | 1⅜ |
| 8 | 16.25 | ¾ | 1½ |
| 8 | 11.25 | ¾ | 1¼ |
| 7 | 17.25 | ¾ | 1½ |
| 7 | 9.75 | ¾ | 1¼ |
| 6 | 13. | ⅝ | 1⅜ |
| 6 | 8. | ⅝ | 1⅛ |
| 5 | 9. | ½ | 1¼ |
| 5 | 6.5 | ½ | 1 |
| 4 | 5.25 | ½ | 1 |
| 3 | 4. | ⅜ | 15/16 |

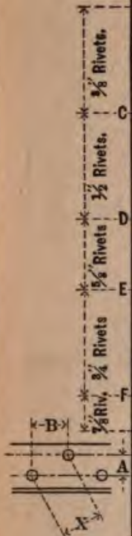
**Ship Channels**

| Depth in Inches | Weight per Foot, Pounds | Diameter of Bolt or Rivet, In. | Inches, A |
|---|---|---|---|
| 13 | 31.5 | ¾ | 2¼ |
| 10 | 21.8 | ¾ | 2 |
| 9 | 28.6 | ¾ | 2¼ |
| 8 | 23.8 | ¾ | 2¼ |
| 8 | 21.4 | ¾ | 2¼ |
| 7 | 18. | ¾ | 2 |
| 6 | 13.3 | ¾ | 1¾ |
| 6 | 15. | ¾ | 1¾ |

**Angles**

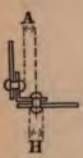
| Depth of Leg, Inches | Maximum Diameter of Bolt or Rivet, Inches | Inches, B |
|---|---|---|
| 8 | 1 | ...... |
| 7 | 1 | ...... |
| 6 | 1 | 3½ |
| 5 | 1 | 2¾ |
| 4½ | 1 | 2½ |
| 4 | 1 | 2¼ |
| 3½ | 1 | 2 |
| 3 | ⅞ | 1¾ |
| 2½ | ¾ | 1⅜ |
| 2 | ⅝ | 1⅛ |
| 1½ | ½ | 13/16 |
| 1 | ⅜ | 9/16 |
| ...... | ...... | ...... |
| ...... | ...... | ...... |
| ...... | ...... | ...... |

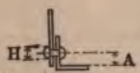
# Minimum Rivet Spacing




| Values of B | VALUES OF "X" FOR VARYING VALUES OF A AND B — VALUES OF A: 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 5/8 | 1 3/4 | 1 7/8 | 2 | 2 1/8 | 2 1/4 | 2 3/8 | 2 1/2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 1/8 | 1 7/16 | 1 1/2 | 1 9/16 | 1 11/16 | 1 3/4 | 1 7/8 | 2 | 2 1/16 | 2 3/16 | 2 5/16 | 2 3/8 | 2 1/2 | 2 5/8 | 2 3/4 |
| 1 1/4 | 1 9/16 | 1 5/8 | 1 11/16 | 1 3/4 | 1 7/8 | 1 15/16 | 2 1/16 | 2 1/8 | 2 1/4 | 2 3/8 | 2 7/16 | 2 9/16 | 2 11/16 | 2 13/16 |
| 1 3/8 | 1 5/8 | 1 11/16 | 1 3/4 | 1 7/8 | 1 15/16 | 2 | 2 1/8 | 2 3/16 | 2 5/16 | 2 7/16 | 2 1/2 | 2 5/8 | 2 3/4 | 2 7/8 |
| 1 1/2 | 1 3/4 | 1 13/16 | 1 7/8 | 1 15/16 | 2 | 2 1/8 | 2 3/16 | 2 5/16 | 2 3/8 | 2 1/2 | 2 5/8 | 2 11/16 | 2 13/16 | 2 15/16 |
| 1 5/8 | 1 7/8 | 1 7/8 | 2 | 2 1/16 | 2 1/8 | 2 3/16 | 2 5/16 | 2 3/8 | 2 1/2 | 2 9/16 | 2 11/16 | 2 3/4 | 2 7/8 | 3 |
| 1 3/4 | 1 15/16 | 2 | 2 1/16 | 2 1/8 | 2 3/16 | 2 5/16 | 2 3/8 | 2 7/16 | 2 9/16 | 2 5/8 | 2 3/4 | 2 7/8 | 2 15/16 | 3 1/16 |
| 1 7/8 | 2 1/16 | 2 1/8 | 2 3/16 | 2 1/4 | 2 5/16 | 2 3/8 | 2 1/2 | 2 9/16 | 2 5/8 | 2 3/4 | 2 13/16 | 2 15/16 | 3 | 3 1/8 |
| 2 | 2 3/16 | 2 1/4 | 2 5/16 | 2 3/8 | 2 7/16 | 2 1/2 | 2 9/16 | 2 5/8 | 2 3/4 | 2 13/16 | 2 15/16 | 3 | 3 1/8 | 3 3/16 |
| 2 1/8 | 2 5/16 | 2 5/16 | 2 3/8 | 2 7/16 | 2 1/2 | 2 5/8 | 2 11/16 | 2 3/4 | 2 13/16 | 2 15/16 | 3 | 3 1/16 | 3 3/16 | 3 1/4 |
| 2 1/4 | 2 7/16 | 2 7/16 | 2 1/2 | 2 9/16 | 2 5/8 | 2 11/16 | 2 3/4 | 2 7/8 | 2 15/16 | 3 | 3 1/16 | 3 3/16 | 3 1/4 | 3 3/8 |
| 2 3/8 | 2 1/2 | 2 9/16 | 2 5/8 | 2 11/16 | 2 3/4 | 2 13/16 | 2 7/8 | 2 15/16 | 3 | 3 1/8 | 3 3/16 | 3 1/4 | 3 3/8 | 3 7/16 |
| 2 1/2 | 2 5/8 | 2 11/16 | 2 3/4 | 2 13/16 | 2 7/8 | 2 15/16 | 3 | 3 1/16 | 3 1/8 | 3 3/16 | 3 1/4 | 3 3/8 | 3 7/16 | 3 9/16 |

Values Below or to Right of Zigzag Line "C" are Large Enough for ½" Rivets
" " " " " " " " "D" " " " " ⅝" "
" " " " " " " " "E" " " " " ¾" "
" " " " " " " " "F" " " " " ⅞" "



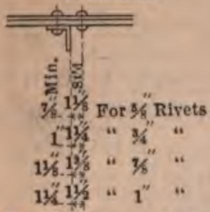




"A" must not be less than ¼" + ½ H


| C Inches | ⅞" Riv. B | ¾" Riv. B |
|---|---|---|
| 1 1/8 | 1 1/2 | 1 3/8 |
| 1 3/16 | 1 7/16 | 1 5/16 |
| 1 1/4 | 1 3/8 | 1 1/4 |
| 1 5/16 | 1 5/16 | 1 3/16 |
| 1 3/8 | 1 1/4 | 1 1/16 |
| 1 7/16 | 1 3/16 | 1 |
| 1 1/2 | 1 1/8 | 7/8 |
| 1 9/16 | 1 1/16 | 13/16 |
| 1 5/8 | 15/16 | 5/8 |
| 1 11/16 | 13/16 | 1/2 |
| 1 3/4 | 11/16 | 0 |

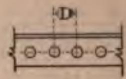
# Minimum Rivet Spacing, Etc.

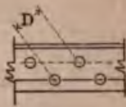
**Clearance for Web Riveting**




Rivets in Crimped Angles

**Minimum Rivet Spacing**

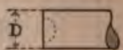



| Diam. of Rivets Inches | D-Min. Inches |
|---|---|
| 1/4 | 1 |
| 3/8 | 1 1/4 |
| 1/2 | 1 3/4 |
| 5/8 | 2 |
| 3/4 | 2 1/4 |
| 7/8 | 2 5/8 |
| 1 | 3 |


Distance Y should be 1 1/2"+thickness of chord angles, but not less than 2"

**Standard Rivet Dies**



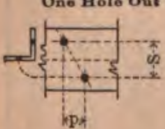

Diameter D=2" for 5/8" Rivets
" =2 1/4 " 3/4" "
" =2 1/2" " 7/8" "


**Clearance for Cover Plate Riveting**
**Dimensions in Inches**

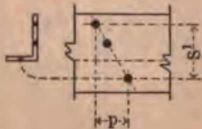
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| f | 1/2 | 1 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/2 | 4 | 4 1/2 | 5 | 5 1/2 | 6 |
| b | 2 1/2 | 2 5/8 | 2 3/4 | 2 3/4 | 2 7/8 | 2 7/8 | 3 | 3 1/8 | 3 1/8 | 3 1/4 | 3 1/4 | 3 3/8 |
| g | 0 | 1/2 | 1 | 1 1/2 | 2 | 2 1/2 | | | | | | |
| b | 2 1/2 | 2 1/4 | 2 1/8 | 2 | 1 1/2 | 0 | | | | | | |

**Staggering of Rivets to Maintain Net Section**

**One Hole Out**




**Two Holes Out**

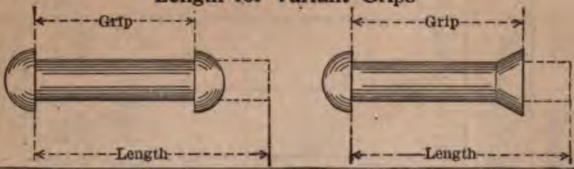



Diameter of Hole taken out, 1/8" greater *than nominal* diameter of rivet

| S | 3/4 Riv. p | 7/8 Riv. p | S | 3/4 Riv. p | 7/8 Riv. p |
|---|---|---|---|---|---|
| 1 | 1 5/8 | 1 3/4 | 5 | 3 1/16 | 3 5/16 |
| 1 1/2 | 1 7/8 | 2 | 5 1/2 | 3 1/4 | 3 1/2 |
| 2 | 2 1/16 | 2 1/4 | 6 | 3 3/8 | 3 5/8 |
| 2 1/2 | 2 1/4 | 2 7/16 | 6 1/2 | 3 1/2 | 3 3/4 |
| 3 | 2 7/16 | 2 5/8 | 7 | 3 5/8 | 3 7/8 |
| 3 1/2 | 2 9/16 | 2 13/16 | 7 1/2 | 3 3/4 | 4 |
| 4 | 2 11/16 | 3 | 8 | 3 7/8 | 4 1/8 |
| 4 1/2 | 2 13/16 | 3 3/16 | 8 1/2 | 4 | 4 1/4 |

# Rivets

## Length for Variant Grips




| Grip in Inches | Diameter in Inches ½ | ⅝ | ¾ | ⅞ | 1 | Grip in Inches | Diameter in Inches ½ | ⅝ | ¾ | ⅞ | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Length in Inches | | | | | | Length in Inches | | | | |
| ½ | 1⅝ | 1⅞ | 2 | 2⅛ | 2¼ | ½ | 1¼ | 1⅜ | 1⅜ | 1½ | 1½ |
| ⅝ | 1¾ | 2 | 2⅛ | 2¼ | 2⅜ | ⅝ | 1⅜ | 1½ | 1½ | 1⅝ | 1⅝ |
| ¾ | 1⅞ | 2⅛ | 2¼ | 2⅜ | 2½ | ¾ | 1½ | 1⅝ | 1⅝ | 1¾ | 1¾ |
| ⅞ | 2 | 2¼ | 2⅜ | 2½ | 2⅝ | ⅞ | 1⅝ | 1¾ | 1¾ | 1⅞ | 1⅞ |
| 1 | 2⅛ | 2⅜ | 2½ | 2⅝ | 2¾ | 1 | 1¾ | 1⅞ | 1⅞ | 2 | 2 |
| 1⅛ | 2¼ | 2½ | 2⅝ | 2¾ | 2⅞ | 1⅛ | 1⅞ | 2 | 2 | 2⅛ | 2⅛ |
| 1¼ | 2⅜ | 2⅝ | 2¾ | 2⅞ | 3 | 1¼ | 2 | 2⅛ | 2⅛ | 2¼ | 2¼ |
| 1⅜ | 2½ | 2¾ | 2⅞ | 3 | 3⅛ | 1⅜ | 2⅛ | 2¼ | 2¼ | 2⅜ | 2⅜ |
| 1½ | 2¾ | 3 | 3⅛ | 3¼ | 3⅜ | 1½ | 2¼ | 2⅜ | 2½ | 2½ | 2⅝ |
| 1⅝ | 2⅞ | 3⅛ | 3¼ | 3⅜ | 3½ | 1⅝ | 2⅜ | 2½ | 2⅝ | 2⅝ | 2¾ |
| 1¾ | 3 | 3¼ | 3⅜ | 3½ | 3⅝ | 1¾ | 2½ | 2⅝ | 2¾ | 2¾ | 2⅞ |
| 1⅞ | 3⅛ | 3⅜ | 3½ | 3⅝ | 3¾ | 1⅞ | 2⅝ | 2¾ | 2⅞ | 2⅞ | 3 |
| 2 | 3¼ | 3½ | 3⅝ | 3¾ | 3⅞ | 2 | 2¾ | 2⅞ | 3 | 3 | 3⅛ |
| 2⅛ | 3⅜ | 3⅝ | 3¾ | 3⅞ | 4 | 2⅛ | 2⅞ | 3 | 3⅛ | 3⅛ | 3¼ |
| 2¼ | 3½ | 3¾ | 3⅞ | 4 | 4⅛ | 2¼ | 3 | 3⅛ | 3¼ | 3¼ | 3⅜ |
| 2⅜ | 3⅝ | 3⅞ | 4 | 4⅛ | 4¼ | 2⅜ | 3⅛ | 3¼ | 3⅜ | 3⅜ | 3½ |
| 2½ | 3¾ | 4 | 4⅛ | 4¼ | 4⅜ | 2½ | 3¼ | 3⅜ | 3½ | 3½ | 3⅝ |
| 2⅝ | 3⅞ | 4⅛ | 4¼ | 4⅜ | 4½ | 2⅝ | 3⅜ | 3½ | 3⅝ | 3⅝ | 3¾ |
| 2¾ | 4 | 4¼ | 4⅜ | 4½ | 4⅝ | 2¾ | 3½ | 3⅝ | 3¾ | 3¾ | 3⅞ |
| 2⅞ | 4⅛ | 4⅜ | 4½ | 4⅝ | 4¾ | 2⅞ | 3⅝ | 3¾ | 3⅞ | 3⅞ | 4 |
| 3 | 4⅜ | 4⅝ | 4¾ | 4⅞ | 5 | 3 | 3⅞ | 3⅞ | 4 | 4⅛ | 4¼ |
| 3⅛ | 4½ | 4¾ | 4⅞ | 5 | 5⅛ | 3⅛ | 4 | 4 | 4⅛ | 4¼ | 4⅜ |
| 3¼ | 4⅝ | 4⅞ | 5 | 5⅛ | 5¼ | 3¼ | 4⅛ | 4¼ | 4¼ | 4⅜ | 4½ |
| 3⅜ | 4¾ | 5 | 5⅛ | 5¼ | 5⅜ | 3⅜ | 4¼ | 4⅜ | 4⅜ | 4½ | 4⅝ |
| 3½ | 4⅞ | 5⅛ | 5¼ | 5⅜ | 5½ | 3½ | 4⅜ | 4½ | 4½ | 4⅝ | 4¾ |
| 3⅝ | 5 | 5¼ | 5⅜ | 5½ | 5⅝ | 3⅝ | 4½ | 4⅝ | 4⅝ | 4¾ | 4⅞ |
| 3¾ | 5⅛ | 5⅜ | 5½ | 5⅝ | 5¾ | 3¾ | 4⅝ | 4¾ | 4¾ | 4⅞ | 5 |
| 3⅞ | 5¼ | 5½ | 5⅝ | 5¾ | 5⅞ | 3⅞ | 4¾ | 4⅞ | 4⅞ | 5 | 5⅛ |
| 4 | 5⅜ | 5⅝ | 5¾ | 5⅞ | 6 | 4 | 4⅞ | 5 | 5⅛ | 5⅛ | 5¼ |
| 4⅛ | 5½ | 5¾ | 5⅞ | 6 | 6⅛ | 4⅛ | 5 | 5⅛ | 5¼ | 5¼ | 5⅜ |
| 4¼ | 5⅝ | 5⅞ | 6 | 6⅛ | 6¼ | 4¼ | 5⅛ | 5¼ | 5⅜ | 5⅜ | 5½ |
| 4⅜ | 5¾ | 6 | 6⅛ | 6¼ | 6⅜ | 4⅜ | 5¼ | 5⅜ | 5½ | 5½ | 5⅝ |
| 4½ | 6 | 6¼ | 6⅜ | 6½ | 6⅝ | 4½ | ...... | ...... | ...... | 5⅝ | 5¾ |
| 4⅝ | 6⅛ | 6⅜ | 6½ | 6⅝ | 6¾ | 4⅝ | ...... | ...... | ...... | 5¾ | 5⅞ |
| 4¾ | 6¼ | 6½ | 6⅝ | 6¾ | 6⅞ | 4¾ | ...... | ...... | ...... | 5⅞ | 6 |
| 4⅞ | 6⅜ | 6⅝ | 6¾ | 6⅞ | 7 | 4⅞ | ...... | ...... | ...... | 6 | 6⅛ |
| 5 | 6½ | 6¾ | 6⅞ | 7 | 7⅛ | 5 | ...... | ...... | ...... | 6⅛ | 6¼ |
| 5⅛ | 6⅝ | 6⅞ | 7 | 7⅛ | 7¼ | 5⅛ | ...... | ...... | ...... | 6¼ | 6⅜ |
| 5¼ | 6¾ | 7 | 7⅛ | 7¼ | 7⅜ | 5¼ | ...... | ...... | ...... | 6⅜ | [illegible] |
| 5⅜ | 6⅞ | 7⅛ | 7¼ | 7⅜ | 7½ | 5⅜ | ...... | ...... | ...... | 6½ | [illegible] |

# Rivets

## Continued

## Shearing and Bearing Value for Quiescent Loads as Used in Buildings

| Diameter of Rivet in In. | | Area of Rivet, Square Inches | Single Shear at 12,000 lbs. per sq. inch | Bearing Value for Different Thicknesses of Plate at 24,000 lbs. per square inch (= Diameter of Rivet × Thickness of Plate × 24,000 lbs.) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction | Decimal | | | 1/4 Inch | 5/16 Inch | 3/8 Inch | 7/16 Inch | 1/2 Inch | 9/16 Inch | 5/8 Inch | 11/16 Inch | 3/4 Inch | 13/16 Inch | 7/8 Inch |
| 3/8 | .375 | .1104 | 1320 | 2250 | 2810 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7/16 | .4375 | .1503 | 1800 | 2625 | 3280 | 3940 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 1/2 | .5 | .1963 | 2360 | 3000 | 3750 | 4500 | 5250 | 6000 | ...... | ...... | ...... | ...... | ...... | ...... |
| 9/16 | .5625 | .2485 | 2980 | 3375 | 4220 | 5060 | 9510 | 6750 | ...... | ...... | ...... | ...... | ...... | ...... |
| 5/8 | .625 | .3068 | 3680 | 3750 | 4690 | 5630 | 6560 | 7500 | 8440 | 9380 | ...... | ...... | ...... | ...... |
| 11/16 | .6875 | .3712 | 4450 | 4125 | 5160 | 6190 | 7220 | 8250 | 9280 | 10310 | ...... | ...... | ...... | ...... |
| 3/4 | .75 | .4418 | 5300 | 4500 | 5630 | 6750 | 7880 | 9000 | 10130 | 11250 | ...... | ...... | ...... | ...... |
| 13/16 | .8125 | .5185 | 6220 | 4875 | 6090 | 7310 | 8530 | 9750 | 10970 | 12190 | 13410 | ...... | ...... | ...... |
| 7/8 | .875 | .6013 | 7220 | 5250 | 6560 | 7880 | 9190 | 10500 | 11810 | 13130 | 14430 | ...... | ...... | ...... |
| 15/16 | .9375 | .6903 | 8280 | 5625 | 7030 | 8440 | 9850 | 11250 | 12660 | 14060 | 15470 | 16880 | ...... | ...... |
| 1 | 1. | .7854 | 9420 | 6000 | 7500 | 9000 | 10500 | 12000 | 13500 | 15000 | 16500 | 18000 | 19500 | ...... |
| 1 1/16 | 1.0625 | .8866 | 10640 | 6375 | 7970 | 9560 | 11160 | 12750 | 14350 | 15940 | 17530 | 19125 | 20720 | 22300 |
| 1 1/8 | 1.125 | .9940 | 11930 | 6750 | 8440 | 10125 | 11810 | 13500 | 15190 | 16875 | 18560 | 20250 | 21940 | 23626 |
| 1 3/16 | 1.1875 | 1.1075 | 13290 | 7125 | 8910 | 10690 | 12470 | 14250 | 16030 | 17810 | 19600 | 21375 | 23160 | 24940 |

# Rivets

## Continued

## Shearing and Bearing Value for Moving Loads as Used in Bridges, Craneways, Etc.

| Diameter of Rivet in Inches | | Area of Rivet, Square Inches | Single Shear at 7500 lbs. per sq. inch | Bearing Value for Different Thicknesses of Plate at 15,000 lbs. per square inch (= Diameter of Rivet × Thickness of Plate × 15,000 lbs.) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fraction | Decimal | | | 1/4 Inch | 5/16 Inch | 3/8 Inch | 7/16 Inch | 1/2 Inch | 9/16 Inch | 5/8 Inch | 11/16 Inch | 3/4 Inch | 13/16 Inch | 7/8 Inch |
| 3/8 | .375 | .1104 | 828 | 1410 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7/16 | .4375 | .1503 | 1130 | 1640 | 2050 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 1/2 | .5 | .1963 | 1470 | 1880 | 2340 | 2810 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 9/16 | .5625 | .2485 | 1860 | 2110 | 2640 | 3160 | 3690 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5/8 | .625 | .3068 | 2300 | 2340 | 2930 | 3520 | 4100 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 11/16 | .6875 | .3712 | 2780 | 2580 | 3220 | 3870 | 4510 | 5160 | ...... | ...... | ...... | ...... | ...... | ...... |
| 3/4 | .75 | .4418 | 3310 | 2810 | 3520 | 4220 | 4920 | 5630 | 6330 | ...... | ...... | ...... | ...... | ...... |
| 13/16 | .8125 | .5185 | 3890 | 3050 | 3810 | 4570 | 5330 | 6090 | 6860 | 7620 | ...... | ...... | ...... | ...... |
| 7/8 | .875 | .6013 | 4510 | 3280 | 4100 | 4920 | 5740 | 6560 | 7380 | 8200 | ...... | ...... | ...... | ...... |
| 15/16 | .9375 | .6903 | 5180 | 3520 | 4390 | 5270 | 6150 | 7030 | 7910 | 8790 | 9670 | ...... | ...... | ...... |
| 1 | 1 | .7854 | 5890 | 3750 | 4690 | 5620 | 6560 | 7500 | 8440 | 9380 | 10310 | 11250 | ...... | ...... |
| 1 1/16 | 1.0625 | .8866 | 6650 | 3980 | 4980 | 5980 | 6970 | 7970 | 8960 | 9960 | 10960 | 11950 | 12950 | ...... |
| 1 1/8 | 1.125 | .9940 | 7460 | 4220 | 5270 | 6330 | 7380 | 8440 | 9490 | 10550 | 11600 | 12660 | 13710 | 14770 |
| 1 3/16 | 1.1875 | 1.1075 | 8310 | 4450 | 5570 | 6680 | 7790 | 8910 | 10020 | 11130 | 12250 | 13360 | 14470 | 15590 |

Rivet values in bearing above heavy horizontal lines are in excess of single shear values.

# Rivets

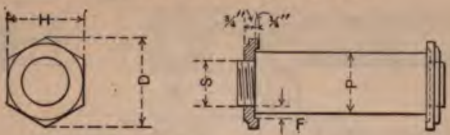
### Continued

## Average Weight of 100 Round Head Rivets

| Length, Inches | Diameter in Inches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1 | 1⅛ | 1¼ |
| 1¼ | 5.5 | 12.9 | 21.9 | 29.3 | 44.0 | 66.6 | 93.3 | 125.5 |
| 1½ | 6.3 | 14.2 | 24.2 | 32.4 | 48.2 | 72.1 | 100.4 | 135.7 |
| 1¾ | 7.0 | 15.6 | 26.3 | 35.6 | 52.4 | 77.7 | 107.1 | 144.8 |
| 2 | 7.9 | 16.9 | 28.4 | 38.7 | 56.7 | 83.2 | 114.2 | 153.0 |
| 2¼ | 8.7 | 18.4 | 30.6 | 41.8 | 61.0 | 88.8 | 121.4 | 162.2 |
| 2½ | 9.4 | 19.8 | 32.8 | 45.0 | 64.3 | 94.4 | 128.5 | 170.3 |
| 2¾ | 10.2 | 21.1 | 35.0 | 48.0 | 69.5 | 100.0 | 135.7 | 179.5 |
| 3 | 11.0 | 22.5 | 37.1 | 51.2 | 73.7 | 105.1 | 142.8 | 187.7 |
| 3¼ | 11.7 | 24.0 | 39.4 | 54.4 | 78.0 | 111.2 | 149.9 | 196.9 |
| 3½ | 12.5 | 25.3 | 41.5 | 57.5 | 82.3 | 116.3 | 157.1 | 205.0 |
| 3¾ | 13.4 | 26.7 | 43.7 | 60.6 | 86.5 | 122.4 | 164.2 | 214.2 |
| 4 | 14.1 | 28.1 | 45.9 | 63.8 | 90.8 | 127.5 | 170.3 | 222.4 |
| 4¼ | 14.9 | 29.5 | 48.0 | 66.9 | 95.1 | 133.6 | 177.5 | 231.5 |
| 4½ | 15.7 | 30.9 | 50.2 | 70.0 | 99.3 | 138.7 | 184.6 | 240.7 |
| 4¾ | 16.5 | 32.2 | 52.4 | 73.1 | 104.0 | 144.8 | 191.8 | 248.9 |
| 5 | 17.2 | 33.7 | 54.6 | 76.3 | 108.1 | 149.9 | 198.9 | 258.1 |
| 5¼ | 18.1 | 35.1 | 56.7 | 79.4 | 112.2 | 156.1 | 206.0 | 266.2 |
| 5½ | 18.8 | 36.4 | 58.9 | 82.5 | 116.3 | 161.2 | 213.2 | 275.4 |
| 5¾ | 19.6 | 37.8 | 61.1 | 85.7 | 120.4 | 166.3 | 220.3 | 283.6 |
| 6 | 20.4 | 39.3 | 63.2 | 88.7 | 124.4 | 172.4 | 227.5 | 292.7 |
| 6½ | 21.9 | 42.0 | 67.6 | 95.1 | 133.6 | 183.6 | 240.7 | 310.1 |
| 7 | 23.5 | 44.8 | 71.9 | 101.3 | 141.8 | 194.8 | 255.0 | 327.4 |
| 7½ | 25.1 | 47.5 | 76.3 | 108.1 | 149.9 | 206.0 | 269.3 | 344.8 |
| 8 | 26.6 | 50.4 | 80.6 | 114.2 | 159.1 | 217.3 | 283.6 | 362.1 |
| 8½ | 28.2 | 53.1 | 85.0 | 120.3 | 167.3 | 227.5 | 297.8 | 379.4 |
| 9 | 29.8 | 55.9 | 89.4 | 126.5 | 176.5 | 238.7 | 312.1 | 396.8 |
| 9½ | 31.3 | 58.8 | 93.6 | 132.6 | 184.6 | 249.9 | 325.4 | 410.1 |
| 10 | 32.8 | 61.5 | 98.0 | 138.7 | 192.8 | 261.1 | 339.7 | 431.5 |
| Heads... | 1.8 | 5.8 | 11.1 | 13.7 | 22.6 | 38.8 | 58.1 | 83.6 |

*In the* above table the length is from under the head.

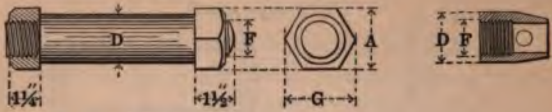
# Standard Shouldered Pins




Eight threads per inch.

| Dimensions in Inches | | | | | Dimensions in Inches | | | | |
|---|---|---|---|---|---|---|---|---|---|
| P | S | D | F | H | P | S | D | F | H |
| 1¼ | ¾ | 2⅞ | ⅜ | 2½ | 5½ | 4 | 7¾ | ⅞ | 6¾ |
| 1⅜ | ¾ | 2⅞ | ⅜ | 2½ | 5⅝ | 4 | 7¾ | ⅞ | 6¾ |
| 1½ | 1 | 3⅛ | ⅜ | 2¾ | 5¾ | 4½ | 8⅛ | ¾ | 7 |
| 1⅝ | 1 | 3⅛ | ⅜ | 2¾ | 5⅞ | 4½ | 8⅛ | ¾ | 7 |
| 1¾ | 1¼ | 3½ | ⅜ | 3 | 6 | 4½ | 8⅜ | ⅞ | 7¼ |
| 1⅞ | 1¼ | 3½ | ⅜ | 3 | 6⅛ | 4½ | 8⅜ | ⅞ | 7¼ |
| 2 | 1½ | 4 | ½ | 3½ | 6¼ | 4½ | 8⅝ | 1 | 7½ |
| 2⅛ | 1½ | 4 | ½ | 3½ | 6⅜ | 4½ | 8⅝ | 1 | 7½ |
| 2¼ | 1½ | 4 | ½ | 3½ | 6½ | 4½ | 8⅝ | 1 | 7½ |
| 2⅜ | 1¾ | 4⅜ | ½ | 3¾ | 6⅝ | 4½ | 9 | 1$\frac{5}{16}$ | 7¾ |
| 2½ | 1¾ | 4⅜ | ½ | 3¾ | 6¾ | 4½ | 9 | 1$\frac{5}{16}$ | 7¾ |
| 2⅝ | 1¾ | 4⅜ | ½ | 3¾ | 6⅞ | 4½ | 9 | 1$\frac{5}{16}$ | 7¾ |
| 2¾ | 2 | 4⅝ | ½ | 4 | 7 | 4½ | 9 | 1$\frac{5}{16}$ | 7¾ |
| 2⅞ | 2 | 4⅝ | ½ | 4 | 7¼ | 5 | 9⅞ | 1⅜ | 8½ |
| 3 | 2¼ | 4⅞ | ½ | 4¼ | 7½ | 5 | 9⅞ | 1⅜ | 8½ |
| 3⅛ | 2¼ | 4⅞ | ½ | 4¼ | 7¾ | 5 | 9⅞ | 1⅜ | 8½ |
| 3¼ | 2½ | 5⅛ | ½ | 4½ | 8 | 5 | 10¾ | 1¾ | 9¼ |
| 3⅜ | 2½ | 5⅛ | ½ | 4½ | 8¼ | 5 | 10¾ | 1¾ | 9¼ |
| 3½ | 2¾ | 5½ | ½ | 4¾ | 8½ | 5 | 10¾ | 1¾ | 9¼ |
| 3⅝ | 2¾ | 5½ | ½ | 4¾ | 8¾ | 6 | 11⅝ | 1⅝ | 10 |
| 3¾ | 3 | 5¾ | ½ | 5 | 9 | 6 | 11⅝ | 1⅝ | 10 |
| 3⅞ | 3 | 5¾ | ½ | 5 | 9¼ | 6 | 11⅝ | 1⅝ | 10 |
| 4 | 3¼ | 6⅛ | ½ | 5¼ | 9½ | 6 | 12⅛ | 1⅞ | 10½ |
| 4⅛ | 3¼ | 6⅛ | ½ | 5¼ | 9¾ | 6 | 12⅛ | 1⅞ | 10½ |
| 4¼ | 3¼ | 6⅛ | ½ | 5¼ | 10 | 7 | 13¼ | 1⅞ | 11½ |
| 4⅜ | 3½ | 6⅝ | ⅝ | 5¾ | 10¼ | 7 | 13¼ | 1⅞ | 11½ |
| 4½ | 3½ | 6⅝ | ⅝ | 5¾ | 10½ | 7 | 13¼ | 1⅞ | 11½ |
| 4⅝ | 3½ | 6⅝ | ⅝ | 5¾ | 10¾ | 7 | 13¼ | 1⅞ | 11½ |
| 4¾ | 3½ | 7 | ⅝ | 6 | 11 | 8 | 14¾ | 2 | 12¾ |
| 4⅞ | 3½ | 7 | ⅝ | 6 | 11¼ | 8 | 14¾ | 2 | 12¾ |
| 5 | 4 | 7¼ | ⅝ | 6¼ | 11½ | 8 | 14¾ | 2 | 12¾ |
| 5⅛ | 4 | 7¼ | ⅝ | 6¼ | 11¾ | 8 | 14¾ | 2 | 12¾ |
| 5¼ | 4 | 7½ | ¾ | 6½ | 12 | 8 | 14¾ | 2 | 12¾ |
| 5⅜ | 4 | 7½ | ¾ | 6½ | | | | | |

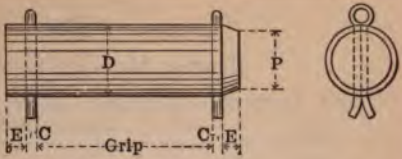
# Bridge Pins, Nuts and Pilot Nuts




All Threads 8 Per Inch　　Pin Nut

| Pins | | | Pin Nuts | | | Diameter of Holes in Eye Bars |
|---|---|---|---|---|---|---|
| Nominal Diameter, Inches | Turned Diameter D, Inches | Diameter Thread F, Inches | Short Diameter A, Inches | Long Diameter G, Inches | Weight, Pounds | |
| 1½ | $1\frac{7}{16}$ | 1¼ | 2 | $2\frac{5}{16}$ | .79 | D+$\frac{1}{100}$ |
| 1¾ | $1\frac{11}{16}$ | 1½ | 2½ | 2⅞ | 1.29 | D+$\frac{1}{100}$ |
| 2 | $1\frac{15}{16}$ | 1½ | 2½ | 2⅞ | 1.29 | D+$\frac{1}{100}$ |
| 2¼ | $2\frac{3}{16}$ | 1½ | 3 | 3½ | 2.12 | D+$\frac{1}{100}$ |
| 2½ | $2\frac{7}{16}$ | 2 | 3 | 3½ | 1.75 | D+$\frac{2}{100}$ |
| 2¾ | $2\frac{11}{16}$ | 2 | 3½ | $4\frac{1}{16}$ | 2.63 | D+$\frac{2}{100}$ |
| 3 | $2\frac{15}{16}$ | 2 | 3½ | $4\frac{1}{16}$ | 2.63 | D+$\frac{2}{100}$ |
| 3¼ | $3\frac{3}{16}$ | 2½ | 4 | $4\frac{11}{16}$ | 3.17 | D+$\frac{2}{100}$ |
| 3½ | $3\frac{7}{16}$ | 2½ | 4 | $4\frac{11}{16}$ | 3.17 | D+$\frac{2}{100}$ |
| 3¾ | $3\frac{11}{16}$ | 2¾ | 4½ | $5\frac{3}{16}$ | 4.12 | D+$\frac{2}{100}$ |
| 4 | $3\frac{15}{16}$ | 3 | 4½ | $5\frac{3}{16}$ | 3.75 | D+$\frac{2}{100}$ |
| 4¼ | $4\frac{3}{16}$ | 3½ | 5 | $5\frac{13}{16}$ | 4.25 | D+$\frac{2}{100}$ |
| 4½ | $4\frac{7}{16}$ | 3½ | 5 | $5\frac{13}{16}$ | 4.25 | D+$\frac{2}{100}$ |
| 4¾ | $4\frac{11}{16}$ | 4 | 5½ | 6⅜ | 4.84 | D+$\frac{2}{100}$ |
| 5 | $4\frac{15}{16}$ | 4 | 5½ | 6⅜ | 4.84 | D+$\frac{3}{100}$ |
| 5¼ | $5\frac{3}{16}$ | 4 | 6 | $6\frac{15}{16}$ | 6.67 | D+$\frac{3}{100}$ |
| 5½ | $5\frac{7}{16}$ | 4 | 6 | $6\frac{15}{16}$ | 6.67 | D+$\frac{3}{100}$ |
| 5¾ | $5\frac{11}{16}$ | 4 | 6½ | 7½ | 8.49 | D+$\frac{3}{100}$ |
| 6 | $5\frac{15}{16}$ | 4 | 6½ | 7½ | 8.49 | D+$\frac{3}{100}$ |
| 6¼ | $6\frac{3}{16}$ | 4 | 7 | 8⅛ | 10.64 | D+$\frac{3}{100}$ |
| 6½ | $6\frac{7}{16}$ | 4 | 7 | 8⅛ | 10.64 | D+$\frac{3}{100}$ |
| 6¾ | $6\frac{11}{16}$ | 4 | 7½ | $8\frac{11}{16}$ | 12.85 | D+$\frac{3}{100}$ |
| 7 | $6\frac{15}{16}$ | 4 | 7½ | $8\frac{11}{16}$ | 12.85 | D+$\frac{3}{100}$ |

# Cold Rolled Steel Cotter Pins

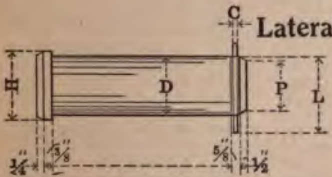


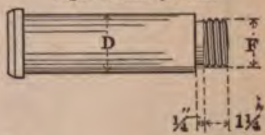

**All Dimensions in Inches**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Pin | D | 1 | 1¼ | 1½ | 1¾ | 2 | 2¼ | 2½ | 2¾ | 3 | 3¼ | 3½ | 3¾ | 4 |
| Diam. of Reduced Pt. | P | ⅞ | 1⅛ | 1¼ | 1½ | 1¾ | 2 | 2¼ | 2½ | 2¾ | 3 | 3¼ | 3½ | 3¾ |
| Lengths of Ends | E | 5/16 | 5/16 | ½ | ½ | ½ | ½ | ½ | ½ | ⅞ | ⅞ | ⅞ | ⅞ | ⅞ |
| Diameter of Cotter... | C | 5/16 | 5/16 | 5/16 | 5/16 | ⅜ | ⅜ | ⅜ | ⅜ | ½ | ½ | ½ | ½ | ½ |

Diameter of pin hole 1/16″ greater than diameter of pin.

# Lateral Pins




**All Dimensions in Inches**

| Pin | | | | | Cotter | |
|---|---|---|---|---|---|---|
| Rough Diameter of Pin | Diameter of Pin Hole | Finished Diameter of Pin | Reduced Point | Diameter of Thread | Diameter | Length |
| H | N | D | P | F | C | L |
| 1½ | 1¼ | 1 7/32 | 1 | 1 | 5/16 | 2 |
| 1¾ | 1½ | 1 15/32 | 1¼ | 1¼ | 5/16 | 2½ |
| 2 | 1¾ | 1 23/32 | 1½ | 1½ | 5/16 | 2¾ |
| 2¼ | 2 | 1 31/32 | 1¾ | 1½ | ⅜ | 3 |
| 2½ | 2¼ | 2 7/32 | 2 | 1½ | ⅜ | 3¼ |
| 2¾ | 2½ | 2 15/32 | 2¼ | 2 | ⅜ | 3¾ |
| 3 | 2¾ | 2 23/32 | 2½ | 2 | ½ | 4 |
| 3¼ | 3 | 2 31/32 | 2¾ | 2 | ½ | 5 |
| 3½ | 3¼ | 3 7/32 | 3 | 2½ | ½ | 5 |
| 3¾ | 3½ | 3 15/32 | 3¼ | 2½ | ½ | 6 |
| 4 | 3¾ | 3 23/32 | 3½ | 2½ | ½ | 6 |

$D = H - \frac{5}{16}''$ $\qquad$ $P = N - \frac{1}{4}''$

# Pins

## Bending Moments in Inch Pounds

Bending Moment = (Diameter of Pin)$^3$ $\times$ 0.098175 $\times$ Stress per Square Inch.

| Pin | | Fiber Stress in Pounds per Square Inch | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter, Inches | Area, Square Inches | 15000 | 18000 | 20000 | 22000 | 22500 | 24000 | 25000 |
| 1 | .785 | 1500 | 1800 | 2000 | 2200 | 2200 | 2400 | 2500 |
| 1¼ | 1.227 | 2900 | 3500 | 3800 | 4200 | 4300 | 4600 | 4800 |
| 1½ | 1.767 | 5000 | 6000 | 6600 | 7300 | 7500 | 8000 | 8300 |
| 1¾ | 2.405 | 7900 | 9500 | 10500 | 11600 | 11800 | 12600 | 13200 |
| 2 | 3.142 | 11800 | 14100 | 15700 | 17300 | 17700 | 18800 | 19600 |
| 2¼ | 3.976 | 16800 | 20100 | 22400 | 24600 | 25200 | 26800 | 28000 |
| 2½ | 4.909 | 23000 | 27600 | 30700 | 33700 | 34500 | 36800 | 38300 |
| 2¾ | 5.940 | 30600 | 36800 | 40800 | 44900 | 45900 | 49000 | 51000 |
| 3 | 7.069 | 39800 | 47700 | 53000 | 58300 | 59600 | 63600 | 66300 |
| 3¼ | 8.296 | 50600 | 60700 | 67400 | 74100 | 75800 | 80900 | 84300 |
| 3½ | 9.621 | 63100 | 75800 | 84200 | 92600 | 94700 | 101000 | 105200 |
| 3¾ | 11.045 | 77700 | 93200 | 103500 | 113900 | 116500 | 124300 | 129400 |
| 4 | 12.566 | 94200 | 113100 | 125700 | 138200 | 141400 | 150800 | 157100 |
| 4¼ | 14.186 | 113000 | 135700 | 150700 | 165800 | 169600 | 180900 | 188400 |
| 4½ | 15.904 | 134200 | 161000 | 178900 | 196800 | 201300 | 214700 | 223700 |
| 4¾ | 17.721 | 157800 | 189400 | 210400 | 231500 | 236700 | 252500 | 263000 |
| 5 | 19.635 | 184100 | 220900 | 245400 | 270000 | 276100 | 294500 | 306800 |
| 5¼ | 21.648 | 213100 | 255700 | 284100 | 312500 | 319600 | 340900 | 355200 |
| 5½ | 23.758 | 245000 | 294000 | 326700 | 359300 | 367500 | 392000 | 408300 |
| 5¾ | 25.967 | 280000 | 336000 | 373300 | 410600 | 419900 | 447900 | 466600 |
| 6 | 28.274 | 318100 | 381700 | 424100 | 466500 | 477100 | 508900 | 530100 |
| 6¼ | 30.680 | 359500 | 431400 | 479400 | 527300 | 539300 | 575200 | 599200 |
| 6½ | 33.183 | 404400 | 485300 | 539200 | 593100 | 606600 | 647100 | 674000 |
| 6¾ | 35.785 | 452900 | 543500 | 603900 | 646300 | 679400 | 724600 | 754800 |
| 7 | 38.485 | 505100 | 606100 | 673500 | 740800 | 757700 | 808200 | 841800 |
| 7¼ | 41.282 | 561200 | 673400 | 748200 | 823100 | 841800 | 897900 | 935300 |
| 7½ | 44.179 | 621300 | 745500 | 828400 | 911200 | 931900 | 994000 | 1035400 |
| 7¾ | 47.173 | 685500 | 822600 | 914000 | 1005400 | 1028200 | 1096800 | 1142500 |
| 8 | 50.265 | 754000 | 904800 | 1005300 | 1105800 | 1131000 | 1206400 | 1256600 |
| 8¼ | 53.456 | 826900 | 992300 | 1102500 | 1212800 | 1240400 | 1323000 | 1378200 |
| 8½ | 56.745 | 904400 | 1085300 | 1205800 | 1326400 | 1356600 | 1447000 | 1507300 |
| 8¾ | 60.132 | 986500 | 1183900 | 1315400 | 1446900 | 1479800 | 1578500 | 1644200 |
| 9 | 63.617 | 1073500 | 1288300 | 1431400 | 1574500 | 1610300 | 1717700 | 1789200 |
| 9¼ | 67.201 | 1165500 | 1398600 | 1554000 | 1709400 | 1748300 | 1864800 | 1942500 |
| 9½ | 70.882 | 1262600 | 1515100 | 1683500 | 1851800 | 1893900 | 2020100 | 2104300 |
| 9¾ | 74.662 | 1364900 | 1637900 | 1819900 | 2001900 | 2047400 | 2183900 | 2274900 |
| 10 | 78.540 | 1472600 | 1767100 | 1963500 | 2159800 | 2208900 | 2356200 | 2454400 |
| 10¼ | 82.516 | 1585900 | 1903000 | 2114500 | 2325900 | 2378800 | 2537400 | 2643100 |
| 10½ | 86.590 | 1704700 | 2045700 | 2273000 | 2500300 | 2557100 | 2727600 | 2841200 |
| 10¾ | 90.763 | 1829400 | 2195300 | 2439200 | 2683200 | 2744100 | 2927100 | 3049100 |
| 11 | 95.033 | 1960100 | 2352100 | 2613400 | 2874800 | 2941000 | 3136100 | 3266800 |
| 11¼ | 99.402 | 2096800 | 2516100 | 2795700 | 3075200 | 3145100 | 3354800 | 3494600 |
| 11½ | 103.869 | 2239700 | 2687600 | 2986200 | 3284900 | 3359500 | 3583500 | 3732800 |
| 11¾ | 108.434 | 2388900 | 2866700 | 3185300 | 3503800 | 3583400 | 3822300 | 3981600 |
| 12 | 113.097 | 2544700 | 3053600 | 3392900 | 3732200 | 3817000 | 4071500 | 4241200 |

# Pin Plates

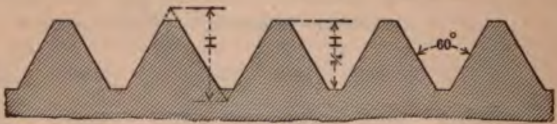
## Bearing Values in Pounds on Metal One Inch Thick

Bearing Value = Diameter of Pin × Bearing Stress per Square Inch

| Pin | | Bearing Stresses in Pounds per Square Inch | | | | |
|---|---|---|---|---|---|---|
| Diameter, Inches | Area, Square Inches | 12000 | 15000 | 20000 | 22000 | 24000 |
| 1 | .785 | 12000 | 15000 | 20000 | 22000 | 24000 |
| 1¼ | 1.227 | 15000 | 18800 | 25000 | 27500 | 30000 |
| 1½ | 1.767 | 18000 | 22500 | 30000 | 33000 | 36000 |
| 1¾ | 2.405 | 21000 | 26300 | 35000 | 38500 | 42000 |
| 2 | 3.142 | 24000 | 30000 | 40000 | 44000 | 48000 |
| 2¼ | 3.976 | 27000 | 33800 | 45000 | 49500 | 54000 |
| 2½ | 4.909 | 30000 | 37500 | 50000 | 55000 | 60000 |
| 2¾ | 5.940 | 33000 | 41300 | 55000 | 60500 | 66000 |
| 3 | 7.069 | 36000 | 45000 | 60000 | 66000 | 72000 |
| 3¼ | 8.296 | 39000 | 48800 | 65000 | 71500 | 78000 |
| 3½ | 9.621 | 42000 | 52500 | 70000 | 77000 | 84000 |
| 3¾ | 11.045 | 45000 | 56300 | 75000 | 82500 | 90000 |
| 4 | 12.566 | 48000 | 60000 | 80000 | 88000 | 96000 |
| 4¼ | 14.186 | 51000 | 63800 | 85000 | 93500 | 102000 |
| 4½ | 15.904 | 54000 | 67500 | 90000 | 99000 | 108000 |
| 4¾ | 17.721 | 57000 | 71300 | 95000 | 104500 | 114000 |
| 5 | 19.635 | 60000 | 75000 | 100000 | 110000 | 120000 |
| 5¼ | 21.648 | 63000 | 78800 | 105000 | 115500 | 126000 |
| 5½ | 23.758 | 66000 | 82500 | 110000 | 121000 | 132000 |
| 5¾ | 25.967 | 69000 | 86300 | 115000 | 126500 | 138000 |
| 6 | 28.274 | 72000 | 90000 | 120000 | 132000 | 144000 |
| 6¼ | 30.680 | 75000 | 93800 | 125000 | 137500 | 150000 |
| 6½ | 33.183 | 78000 | 97500 | 130000 | 143000 | 156000 |
| 6¾ | 35.785 | 81000 | 101300 | 135000 | 148500 | 162000 |
| 7 | 38.485 | 84000 | 105000 | 140000 | 154000 | 168000 |
| 7¼ | 41.282 | 87000 | 108800 | 145000 | 159500 | 174000 |
| 7½ | 44.179 | 90000 | 112500 | 150000 | 165000 | 180000 |
| 7¾ | 47.173 | 93000 | 116300 | 155000 | 170500 | 186000 |
| 8 | 50.265 | 96000 | 120000 | 160000 | 176000 | 192000 |
| 8¼ | 53.456 | 99000 | 123800 | 165000 | 181500 | 198000 |
| 8½ | 56.745 | 102000 | 127500 | 170000 | 187000 | 204000 |
| 8¾ | 60.132 | 105000 | 131300 | 175000 | 192500 | 210000 |
| 9 | 63.617 | 108000 | 135000 | 180000 | 198000 | 216000 |
| 9¼ | 67.201 | 111000 | 138800 | 185000 | 203500 | 222000 |
| 9½ | 70.882 | 114000 | 142500 | 190000 | 209000 | 228000 |
| 9¾ | 74.662 | 117000 | 146300 | 195000 | 214500 | 234000 |
| 10 | 78.540 | 120000 | 150000 | 200000 | 220000 | 240000 |
| 10¼ | 82.516 | 123000 | 153800 | 205000 | 225500 | 246000 |
| 10½ | 86.590 | 126000 | 157500 | 210000 | 231000 | 252000 |
| 10¾ | 90.763 | 129000 | 161300 | 215000 | 236500 | 258000 |
| 11 | 95.033 | 132000 | 165000 | 220000 | 242000 | 264000 |
| 11¼ | 99.402 | 135000 | 168800 | 225000 | 247500 | 270000 |
| 11½ | 103.869 | 138000 | 172500 | 230000 | 253000 | 276000 |
| 11¾ | 108.434 | 141000 | 176300 | 235000 | 258500 | 282000 |
| 12 | 113.097 | 144000 | 180000 | 240000 | 264000 | [illegible] |

# Standard Screw Threads, Nuts and Bolt Heads

Recommended by Franklin Institute, December 15, 1864, and adopted by Navy Department of the United States, by the R. R. Master Mechanics' and Master Car-Builders' Association and by the Jones & Laughlin Steel Company.




Angle of thread 60°. Flat at top and bottom ⅛ of pitch.

| Diameter of Screw, Inches | Threads per Inch | Diameter at Root of Thread, Inches | Diameter of Screw, Inches | Threads per Inch | Diameter at Root of Thread, Inches |
|---|---|---|---|---|---|
| ¼ | 20 | .185 | 2 | 4½ | 1.712 |
| 5/16 | 18 | .240 | 2¼ | 4½ | 1.962 |
| ⅜ | 16 | .294 | 2½ | 4 | 2.176 |
| 7/16 | 14 | .344 | 2¾ | 4 | 2.426 |
| ½ | 13 | .400 | 3 | 3½ | 2.629 |
| 9/16 | 12 | .454 | 3¼ | 3½ | 2.879 |
| ⅝ | 11 | .507 | 3½ | 3¼ | 3.100 |
| ¾ | 10 | .620 | 3¾ | 3 | 3.317 |
| ⅞ | 9 | .731 | 4 | 3 | 3.567 |
| 1 | 8 | .837 | 4¼ | 2⅞ | 3.798 |
| 1⅛ | 7 | .940 | 4½ | 2¾ | 4.028 |
| 1¼ | 7 | 1.065 | 4¾ | 2⅝ | 4.256 |
| 1⅜ | 6 | 1.160 | 5 | 2½ | 4.480 |
| 1½ | 6 | 1.284 | 5¼ | 2½ | 4.730 |
| 1⅝ | 5½ | 1.389 | 5½ | 2⅜ | 4.953 |
| 1¾ | 5 | 1.491 | 5¾ | 2⅜ | 5.203 |
| 1⅞ | 5 | 1.616 | 6 | 2¼ | 5.423 |

Nuts and bolt heads are determined by the following rules, which apply to both square and hexagon nuts:

Short diameter of rough nut = 1½ × diameter of bolt + ⅛-inch.
Short diameter of finished nut = 1½ × diameter of bolt + 1/16-inch.
Thickness of rough nut = diameter of bolt.
Thickness of finished nut = diameter of bolt — 1/16-inch.
Short diameter of rough head = 1½ × diameter of bolt + ⅛-inch.
Short diameter of finished head = 1½ × diameter of bolt + 1/16-inch.
Thickness of rough head = ½ short diameter of head.
Thickness of finished head = diameter of bolt — 1/16-inch.

The long diameter of a hexagon nut may be obtained by multiplying the -ort diameter by 1.155 and the long diameter of a square nut by multiplying *hort diameter by 1.414.*

# Square Head Machine Bolts

## Average Weight of 100 Bolts

| Length, Inches | Diameter, Inches | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ¼ | 5/16 | ⅜ | 7/16 | ½ | ⅝ | ¾ | ⅞ | 1 |
| 1½ | 4.0 | 6.8 | 10.6 | 15.0 | 23.9 | 40.5 | 70.0 | ........ | ........ |
| 1¾ | 4.4 | 7.3 | 11.3 | 16.1 | 25.1 | 42.7 | 73.1 | ........ | ........ |
| 2 | 4.7 | 7.8 | 12.0 | 17.2 | 26.3 | 44.8 | 76.2 | ........ | ........ |
| 2¼ | 5.1 | 8.4 | 12.6 | 18.2 | 27.7 | 47.0 | 79.3 | ........ | ........ |
| 2½ | 5.4 | 8.9 | 13.3 | 19.2 | 29.0 | 49.2 | 82.4 | 120.5 | ........ |
| 2¾ | 5.8 | 9.5 | 14.0 | 20.2 | 30.4 | 51.4 | 85.5 | 124.7 | ........ |
| 3 | 6.1 | 10.0 | 14.7 | 21.2 | 31.8 | 53.5 | 88.7 | 128.9 | 185.0 |
| 3½ | 6.8 | 11.1 | 16.0 | 23.2 | 34.7 | 57.9 | 95.0 | 137.4 | 196.0 |
| 4 | 7.5 | 12.2 | 17.4 | 25.2 | 37.5 | 62.3 | 101.2 | 145.8 | 207.0 |
| 4½ | 8.2 | 13.2 | 18.7 | 27.2 | 40.2 | 66.7 | 107.5 | 159.2 | 218.0 |
| 5 | 8.9 | 14.3 | 20.0 | 29.1 | 43.0 | 71.0 | 113.7 | 167.7 | 229.0 |
| 5½ | 9.6 | 15.4 | 21.4 | 31.2 | 45.7 | 75.4 | 120.0 | 176.1 | 240.0 |
| 6 | 10.3 | 16.5 | 22.8 | 33.1 | 48.4 | 79.8 | 126.2 | 184.6 | 251.0 |
| 6½ | 11.0 | 17.6 | 24.1 | 35.1 | 51.2 | 84.1 | 132.5 | 193.0 | 262.0 |
| 7 | 11.7 | 18.6 | 25.9 | 37.1 | 54.0 | 88.5 | 138.7 | 201.4 | 273.0 |
| 7½ | 12.4 | 19.7 | 27.7 | 39.1 | 56.7 | 92.9 | 145.0 | 209.9 | 284.0 |
| 8 | 13.1 | 20.8 | 29.5 | 41.0 | 59.4 | 97.2 | 151.2 | 218.3 | 295.0 |
| 9 | ........ | ........ | 33.1 | 45.0 | 64.8 | 106.0 | 163.7 | 240.2 | 317.0 |
| 10 | ........ | ........ | 36.7 | 49.0 | 70.3 | 114.7 | 176.2 | 257.1 | 339.0 |
| 11 | ........ | ........ | 40.4 | 53.0 | 75.8 | 123.5 | 188.7 | 273.9 | 360.0 |
| 12 | ........ | ........ | 44.0 | 57.0 | 81.3 | 132.2 | 201.0 | 290.0 | 382.0 |
| 13 | ........ | ........ | ........ | ........ | 86.7 | 140.7 | 213.4 | 307.7 | 404.0 |
| 14 | ........ | ........ | ........ | ........ | 92.2 | 149.2 | 225.9 | 324.5 | 426.0 |
| 15 | ........ | ........ | ........ | ........ | 97.7 | 157.6 | 238.3 | 341.4 | 448.0 |
| 16 | ........ | ........ | ........ | ........ | 103.1 | 166.1 | 250.8 | 358.3 | 470.0 |
| 17 | ........ | ........ | ........ | ........ | 108.6 | 174.6 | 263.2 | 375.2 | 492.0 |
| 18 | ........ | ........ | ........ | ........ | 114.1 | 183.1 | 275.6 | 392.0 | 514.0 |
| 19 | ........ | ........ | ........ | ........ | 119.5 | 191.5 | 288.1 | 408.9 | 536.0 |
| 20 | ........ | ........ | ........ | ........ | 125.0 | 200.0 | 300.5 | 425.8 | 558.0 |
| Per inch additional | 1.4 | 2.2 | 3.6 | 4.0 | 5.5 | 8.5 | 12.4 | 16.9 | 22.0 |

# Nuts and Bolt Heads

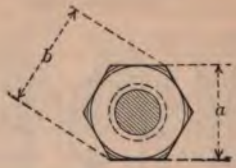
## Approximate Weight in Pounds

| Diameter of Bolt, Inches | ¼ | 5/16 | ⅜ | 7/16 | ½ | ⅝ | ¾ |
|---|---|---|---|---|---|---|---|
| Weight of Hexagon Nut and Head.. | .017 | .042 | .057 | .109 | .128 | .267 | .43 |
| Weight of Square Nut and Head... | .021 | .049 | .069 | .120 | .164 | .320 | .55 |

| Diameter of Bolt, Inches | ⅞ | 1 | 1¼ | 1½ | 1¾ | 2 | 2½ |
|---|---|---|---|---|---|---|---|
| Weight of Hexagon Nut and Head.. | .73 | 1.10 | 2.14 | 3.78 | 5.6 | 8.75 | 17.0 |
| Weight of Square Nut and Head... | .88 | 1.31 | 2.56 | 4.42 | 7.0 | 10.5 | 21.0 |

# Hot Pressed Hexagon Nuts

## Sizes and Weights—United States Standard

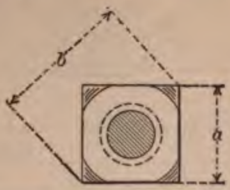



| Dimensions a | Dimensions b | Thickness, Inches | Size of Hole | | Size of Bolt, Inches | Weight of 100 Nuts | Number of Nuts in 100 Pounds |
|---|---|---|---|---|---|---|---|
| 1/2 | .58 | 1/4 | 0.185 | 3/16 scant | 1/4 | 1.3 | 7615 |
| 19/32 | .68 | 5/16 | 0.240 | 1/4 scant | 5/16 | 1.9 | 5200 |
| 11/16 | .79 | 3/8 | 0.294 | 19/64 scant | 3/8 | 3.3 | 3000 |
| 25/32 | .90 | 7/16 | 0.344 | 11/32 | 7/16 | 5.0 | 2000 |
| 7/8 | 1.01 | 1/2 | 0.400 | 13/32 scant | 1/2 | 7.0 | 1430 |
| 31/32 | 1.12 | 9/16 | 0.454 | 29/64 | 9/16 | 9.1 | 1100 |
| 1 1/16 | 1.23 | 5/8 | 0.507 | 1/2 full | 5/8 | 13.5 | 740 |
| 1 1/4 | 1.44 | 3/4 | 0.620 | 5/8 scant | 3/4 | 22.2 | 450 |
| 1 7/16 | 1.66 | 7/8 | 0.731 | 47/64 scant | 7/8 | 32.4 | 309 |
| 1 5/8 | 1.88 | 1 | 0.837 | 27/32 scant | 1 | 46.3 | 216 |
| 1 13/16 | 2.09 | 1 1/8 | 0.940 | 15/16 full | 1 1/8 | 67.6 | 148 |
| 2 | 2.31 | 1 1/4 | 1.065 | 1 1/16 full | 1 1/4 | 90.1 | 111 |
| 2 3/16 | 2.53 | 1 3/8 | 1.160 | 1 5/32 full | 1 3/8 | 117.5 | 85 |
| 2 3/8 | 2.74 | 1 1/2 | 1.284 | 1 9/32 full | 1 1/2 | 147.1 | 68 |
| 2 9/16 | 2.96 | 1 5/8 | 1.389 | 1 25/64 scant | 1 5/8 | 178.6 | 56 |
| 2 3/4 | 3.18 | 1 3/4 | 1.491 | 1 1/2 scant | 1 3/4 | 250.0 | 40 |
| 2 15/16 | 3.39 | 1 7/8 | 1.616 | 1 5/8 scant | 1 7/8 | 285.7 | 35 |
| 3 1/8 | 3.61 | 2 | 1.712 | 1 23/32 scant | 2 | 344.8 | 29 |
| 3 5/16 | 3.82 | 2 1/8 | 1.836 | 1 27/32 scant | 2 1/8 | 384.6 | 26 |
| 3 1/2 | 4.04 | 2 1/4 | 1.962 | 1 31/32 scant | 2 1/4 | 434.8 | 23 |

Both weights and sizes are for unfinished nuts.

# Hot Pressed Square Nuts

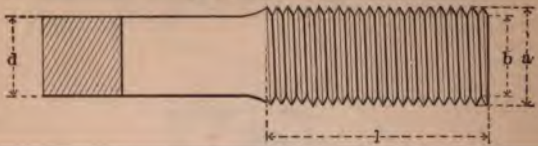
## Sizes and Weights—United States Standard




| Dimensions a | Dimensions b | Thickness, Inches | Size of Hole | | Size of Bolt, Inches | Weight of 100 Nuts | Number of Nuts in 100 Pounds |
|---|---|---|---|---|---|---|---|
| 1/2 | .71 | 1/4 | 0.185 | 3/16 scant | 1/4 | 1.4 | 7270 |
| 19/32 | .84 | 5/16 | 0.240 | 1/4 scant | 5/16 | 2.2 | 4700 |
| 11/16 | .97 | 3/8 | 0.294 | 19/64 scant | 3/8 | 4.3 | 2350 |
| 25/32 | 1.11 | 7/16 | 0.344 | 11/32 | 7/16 | 6.1 | 1630 |
| 7/8 | 1.24 | 1/2 | 0.400 | 13/32 scant | 1/2 | 9.0 | 1120 |
| 31/32 | 1.37 | 9/16 | 0.454 | 29/64 | 9/16 | 11.2 | 890 |
| 1 1/16 | 1.50 | 5/8 | 0.507 | 1/2 full | 5/8 | 15.6 | 640 |
| 1 1/4 | 1.77 | 3/4 | 0.620 | 5/8 scant | 3/4 | 26.3 | 380 |
| 1 7/16 | 2.03 | 7/8 | 0.731 | 47/64 scant | 7/8 | 35.7 | 280 |
| 1 5/8 | 2.30 | 1 | 0.837 | 27/32 scant | 1 | 58.8 | 170 |
| 1 13/16 | 2.56 | 1 1/8 | 0.940 | 15/16 full | 1 1/8 | 76.9 | 130 |
| 2 | 2.83 | 1 1/4 | 1.065 | 1 1/16 full | 1 1/4 | 104.2 | 96 |
| 2 3/16 | 3.09 | 1 3/8 | 1.160 | 1 5/32 full | 1 3/8 | 142.8 | 70 |
| 2 3/8 | 3.36 | 1 1/2 | 1.284 | 1 9/32 full | 1 1/2 | 172.4 | 58 |
| 2 9/16 | 3.62 | 1 5/8 | 1.389 | 1 25/64 scant | 1 5/8 | 227.3 | 44 |
| 2 3/4 | 3.89 | 1 3/4 | 1.491 | 1 1/2 scant | 1 3/4 | 294.1 | 34 |
| 2 15/16 | 4.15 | 1 7/8 | 1.616 | 1 5/8 scant | 1 7/8 | 370.4 | 27 |
| 3 1/8 | 4.42 | 2 | 1.712 | 1 23/32 scant | 2 | 416.7 | 24 |
| 3 5/16 | 4.68 | 2 1/8 | 1.836 | 1 27/32 scant | 2 1/8 | 500.0 | 20 |
| 3 1/2 | 4.95 | 2 1/4 | 1.962 | 1 31/32 scant | 2 1/4 | 588.2 | 17 |

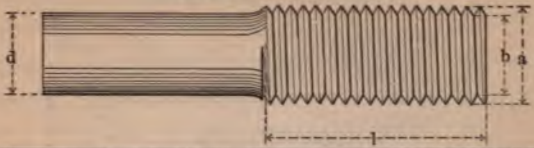
Both weights and sizes are for unfinished nuts.

# Upset Screw Ends
## For Square Bars




| Body of Bar | | | | Upset Ends | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Side of Square *d*, Inches | Area, Square Inches | Weight per Foot, Pounds | Add for Upset, Inches | Diameter of Screw *a*, Inches | Length of Upset *l*, Inches | Area at Root of Thread, Square Inches | Diameter at Root of Thread *b*, Inches | Number of Threads per Inch | Excess of Area at Root of Thread over that of Body of Bar, % |
| ½ | .250 | .851 | 4 | ¾ | 4¼ | .302 | .620 | 10 | 21 |
| ⅝ | .391 | 1.329 | 5¾ | 1 | 4½ | .550 | .837 | 8 | 41 |
| ¾ | .563 | 1.914 | 4½ | 1⅛ | 4¾ | .694 | .939 | 7 | 23 |
| ⅞ | .766 | 2.605 | 5¾ | 1⅜ | 5 | 1.057 | 1.160 | 6 | 38 |
| 1 | 1.000 | 3.402 | 4¾ | 1½ | 5 | 1.295 | 1.284 | 6 | 29 |
| 1⅛ | 1.266 | 4.306 | 4¼ | 1⅝ | 5¼ | 1.515 | 1.389 | 5½ | 20 |
| 1¼ | 1.563 | 5.316 | 5¼ | 1⅞ | 5½ | 2.048 | 1.615 | 5 | 31 |
| 1⅜ | 1.891 | 6.432 | 4½ | 2 | 5½ | 2.302 | 1.712 | 4½ | 22 |
| 1½ | 2.250 | 7.655 | 4¼ | 2⅛ | 5¾ | 2.650 | 1.837 | 4½ | 18 |
| 1⅝ | 2.641 | 8.984 | 5 | 2⅜ | 6 | 3.419 | 2.087 | 4½ | 30 |
| 1¾ | 3.063 | 10.419 | 4½ | 2½ | 6 | 3.715 | 2.175 | 4 | 21 |
| 1⅞ | 3.516 | 11.961 | 4¼ | 2⅝ | 6¼ | 4.155 | 2.300 | 4 | 18 |
| 2 | 4.000 | 13.610 | 5 | 2⅞ | 6½ | 5.108 | 2.550 | 4 | 28 |
| 2⅛ | 4.516 | 15.360 | 4½ | 3 | 6½ | 5.428 | 2.629 | 3½ | 20 |
| 2¼ | 5.063 | 17.220 | 4¼ | 3⅛ | 6¾ | 5.957 | 2.754 | 3½ | 18 |
| 2⅜ | 5.641 | 19.190 | 5¼ | 3⅜ | 7 | 7.087 | 3.004 | 3½ | 26 |
| 2½ | 6.250 | 21.260 | 4¾ | 3½ | 7 | 7.548 | 3.100 | 3¼ | 21 |
| 2⅝ | 6.891 | 23.440 | 4½ | 3⅝ | 7¼ | 8.171 | 3.225 | 3¼ | 19 |
| 2¾ | 7.563 | 25.73 | 5¼ | 3⅞ | 7½ | 9.305 | 3.442 | 3 | 23 |
| 2⅞ | 8.266 | 28.12 | 4¾ | 4 | 7½ | 9.993 | 3.567 | 3 | 21 |
| 3 | 9.000 | 30.62 | 4½ | 4⅛ | 7¾ | 10.706 | 3.692 | 3 | 19 |
| 3⅛ | 9.766 | 33.23 | 5¼ | 4⅜ | 8 | 12.087 | 3.923 | 2⅞ | 24 |
| 3¼ | 10.563 | 35.94 | 5 | 4½ | 8 | 12.743 | 4.028 | 2¾ | 21 |
| 3⅜ | 11.391 | 38.75 | 5 | 4⅝ | 8¼ | 13.544 | 4.153 | 2¾ | 19 |
| 3½ | 12.250 | 41.68 | 5½ | 4⅞ | 8½ | 15.068 | 4.380 | 2⅝ | 23 |
| 3⅝ | 13.141 | 44.71 | 5¼ | 5 | 8½ | 15.763 | 4.480 | 2½ | 20 |
| 3¾ | 14.063 | 47.84 | 5 | 5⅛ | 8¾ | 16.658 | 4.605 | 2½ | 18 |
| 3⅞ | 15.016 | 51.09 | 4¾ | 5¼ | 8¾ | 17.572 | 4.731 | 2½ | 17 |
| [illegible] | 16.000 | 54.45 | 5¼ | 5½ | 9 | 19.267 | 4.952 | 2⅜ | 20 |

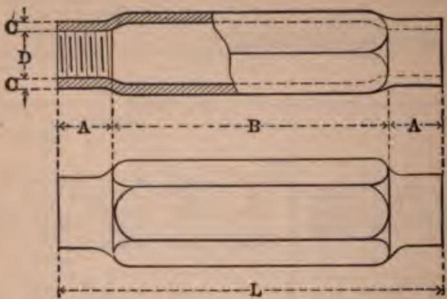
# Upset Screw Ends
## For Round Bars




| Body of Bar | | | | Upset Ends | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Diameter d, Inches | Area, Square Inches | Weight per Foot, Pounds | Add for Upset, Inches | Diameter of Screw a, Inches | Length of Upset l, Inches | Area at Root of Thread, Square Inches | Diameter at Root of Thread b, Inches | Number of Threads per Inch | Excess of Area at Root of Thread over that of Body of Bar, % |
| ½ | .196 | .668 | 6½ | ¾ | 4¼ | .302 | .620 | 10 | 54 |
| ⅝ | .307 | 1.044 | 5½ | ⅞ | 4½ | .420 | .731 | 9 | 37 |
| ¾ | .442 | 1.503 | 4½ | 1 | 4½ | .55 | .837 | 8 | 25 |
| ⅞ | .601 | 2.046 | 6¼ | 1¼ | 4¾ | .893 | 1.065 | 7 | 48 |
| 1 | .785 | 2.672 | 5¼ | 1⅜ | 5 | 1.057 | 1.160 | 6 | 35 |
| 1⅛ | .994 | 3.382 | 4¾ | 1½ | 5 | 1.295 | 1.284 | 6 | 30 |
| 1¼ | 1.227 | 4.175 | 4½ | 1⅝ | 5¼ | 1.515 | 1.389 | 5½ | 23 |
| 1⅜ | 1.485 | 5.052 | 4 | 1¾ | 5¼ | 1.744 | 1.490 | 5 | 18 |
| 1½ | 1.767 | 6.012 | 5¼ | 2 | 5½ | 2.302 | 1.712 | 4½ | 30 |
| 1⅝ | 2.074 | 7.056 | 5 | 2⅛ | 5¾ | 2.650 | 1.837 | 4½ | 28 |
| 1¾ | 2.405 | 8.183 | 4¾ | 2¼ | 5¾ | 3.023 | 1.962 | 4½ | 26 |
| 1⅞ | 2.761 | 9.394 | 4½ | 2⅜ | 6 | 3.419 | 2.087 | 4½ | 24 |
| 2 | 3.142 | 10.69 | 4¼ | 2½ | 6 | 3.715 | 2.175 | 4 | 18 |
| 2⅛ | 3.547 | 12.06 | 4 | 2⅝ | 6¼ | 4.155 | 2.300 | 4 | 17 |
| 2¼ | 3.976 | 13.52 | 5¼ | 2⅞ | 6½ | 5.108 | 2.550 | 4 | 28 |
| 2⅜ | 4.430 | 15.07 | 4¾ | 3 | 6½ | 5.428 | 2.629 | 3½ | 23 |
| 2½ | 4.909 | 16.70 | 4¾ | 3⅛ | 6¾ | 5.957 | 2.754 | 3½ | 21 |
| 2⅝ | 5.412 | 18.41 | 4½ | 3¼ | 6¾ | 6.510 | 2.879 | 3½ | 20 |
| 2¾ | 5.940 | 20.21 | 4½ | 3⅜ | 7 | 7.087 | 3.004 | 3½ | 19 |
| 2⅞ | 6.492 | 22.09 | 5¼ | 3⅝ | 7¼ | 8.171 | 3.225 | 3¼ | 26 |
| 3 | 7.069 | 24.05 | 5 | 3¾ | 7¼ | 8.641 | 3.317 | 3 | 22 |
| 3⅛ | 7.670 | 26.10 | 5¼ | 3⅞ | 7½ | 9.305 | 3.442 | 3 | 21 |
| 3¼ | 8.296 | 28.23 | 4¾ | 4 | 7½ | 9.993 | 3.567 | 3 | 20 |
| 3⅜ | 8.946 | 30.43 | 4¾ | 4⅛ | 7¾ | 10.706 | 3.692 | 3 | 20 |
| 3½ | 9.621 | 32.74 | 4½ | 4¼ | 8 | 11.329 | 3.798 | 2⅞ | 18 |
| 3⅝ | 10.321 | 35.12 | 5¼ | 4½ | 8 | 12.743 | 4.028 | 2¾ | 23 |
| 3¾ | 11.045 | 37.57 | 5¼ | 4⅝ | 8¼ | 13.544 | 4.153 | 2¾ | 22 |
| 3⅞ | 11.793 | 40.13 | 5 | 4¾ | 8½ | 14.220 | 4.255 | 2⅝ | [illegible] |

# Standard Sleeve Nuts

## Dimensions and Weights



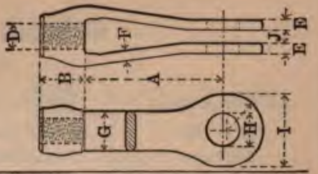

| Size, Inches | D | L | A | B | C | Size, Inches | D | L | A | B | C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¾ | ¾ | 8 | 1 | 6 | ¼ | 2 | 2 | 10 | 2¼ | 5½ | ½ |
| ⅞ | ⅞ | 8 | 1⅛ | 5¾ | ¼ | 2⅛ | 2⅛ | 10 | 2⅜ | 5¼ | ½ |
| 1 | 1 | 8 | 1¼ | 5½ | 5/16 | 2¼ | 2¼ | 10 | 2½ | 5 | ½ |
| 1⅛ | 1⅛ | 8 | 1⅜ | 5¼ | 5/16 | 2⅜ | 2⅜ | 10 | 2⅝ | 4¾ | 9/16 |
| 1¼ | 1¼ | 8 | 1½ | 5 | 5/16 | 2½ | 2½ | 10 | 2¾ | 4½ | 9/16 |
| 1⅜ | 1⅜ | 8 | 1⅝ | 4¾ | ⅜ | 2⅝ | 2⅝ | 10 | 2⅞ | 4¼ | 9/16 |
| 1½ | 1½ | 8 | 1¾ | 4½ | ⅜ | 2¾ | 2¾ | 10 | 3 | 4 | ⅝ |
| 1⅝ | 1⅝ | 8 | 1⅞ | 4¼ | 7/16 | 2⅞ | 2⅞ | 10 | 3⅛ | 3¾ | ⅝ |
| 1¾ | 1¾ | 8 | 2 | 4 | 7/16 | 3 | 3 | 10 | 3¼ | 3½ | 11/16 |
| 1⅞ | 1⅞ | 8 | 2⅛ | 3¾ | 7/16 | ..... | ..... | ..... | ..... | ..... | ..... |

## Standard Clevis Nuts

### Dimensions and Weights

**Diameter of Head for Various Given Sizes of Pins**

**Used with Steel Rods 68,000 lbs. per sq. in.**




| D | A | B | Sizes of Pin 1 | 1¼ | 1½ | 1¾ | 2 | 2¼ | 2½ | 2¾ | 3 | 3¼ | 3½ | 3¾ | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ¾ | 5½ | 1⅛ | 2¾ | 2¾ | 2¾ | 3 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| ⅞ | 5½ | 1⅜ | 2¾ | 2¾ | 3 | 3 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1 | 6 | 1½ | 2¾ | 2¾ | 3 | 3¼ | 3½ | ... | ... | ... | ... | ... | ... | ... | ... |
| 1⅛ | 6 | 1¾ | ... | 2¾ | 3 | 3¼ | 3½ | 3¾ | ... | ... | ... | ... | ... | ... | ... |
| 1¼ | 6½ | 1⅞ | ... | 3 | 3¼ | 3½ | 3½ | 3¾ | ... | ... | ... | ... | ... | ... | ... |
| 1⅜ | 6½ | 2⅛ | ... | 3¼ | 3½ | 3¾ | 4 | 4⅜ | 4⅜ | ... | ... | ... | ... | ... | ... |
| 1½ | 7 | 2¼ | ... | ... | 3¾ | 4 | 4⅜ | 4⅜ | 4¾ | ... | ... | ... | ... | ... | ... |
| 1⅝ | 7 | 2½ | ... | ... | 3¾ | 4 | 4⅜ | 4¾ | 5¼ | ... | ... | ... | ... | ... | ... |
| 1¾ | 8 | 2⅝ | ... | ... | ... | 4⅜ | 4¾ | 5¼ | 5¼ | 5¼ | ... | ... | ... | ... | ... |
| 1⅞ | 8 | 2⅞ | ... | ... | ... | ... | 5¼ | 5¼ | 5¼ | 5¾ | ... | ... | ... | ... | ... |
| 2 | 9 | 3 | ... | ... | ... | ... | 5¼ | 5¼ | 5¾ | 5¾ | 6¾ | ... | ... | ... | ... |
| 2⅛ | 9 | 3¼ | ... | ... | ... | ... | ... | 5¾ | 5¾ | 6¾ | 6¾ | 6¾ | ... | ... | ... |
| 2¼ | 10 | 3¼ | ... | ... | ... | ... | ... | 5¾ | 6¾ | 6¾ | 6¾ | 6¾ | ... | ... | ... |
| 2⅜ | 10 | 3½ | ... | ... | ... | ... | ... | 6¾ | 6¾ | 6¾ | 6¾ | 8 | 8 | ... | ... |
| 2½ | 10 | 3¾ | ... | ... | ... | ... | ... | ... | 6¾ | 6¾ | 8 | 8 | 8 | ... | ... |
| 2⅝ | 10 | 4 | ... | ... | ... | ... | ... | ... | 6¾ | 8 | 8 | 8 | 8 | 8 | 8 |
| 2¾ | 12 | 4¼ | ... | ... | ... | ... | ... | ... | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 2⅞ | 12 | 4¼ | ... | ... | ... | ... | ... | ... | ... | 8 | 8 | 8 | 8 | 9 | 9 |
| 3 | 12 | 4½ | ... | ... | ... | ... | ... | ... | ... | ... | 8 | 8 | 9 | 9 | 9 |

All Clevis Nuts with Diameter I—8 in. or larger Dimension A will be 12 in.

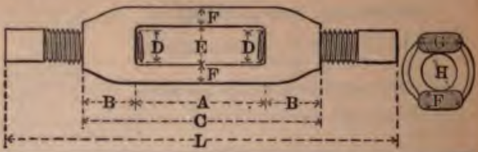
**Dimension E, F, G for Various Diameters I**

| I | E | F | G | I | E | F | G | Weights of Clevises: Diameter D, Inches | Weight, Pounds |
|---|---|---|---|---|---|---|---|---|---|
| 2¾ | 17/32 | ½ | 1½ | 4¾ | 25/32 | 23/32 | 2½ | ¾ to 1½ | 5 to 8 |
| 3 | 17/32 | ½ | 1⅝ | 5¼ | ⅞ | 13/16 | 2¾ | 1⅝ to 2 | 9 to 15 |
| 3¼ | 19/32 | 9/16 | 1¾ | 5¾ | 15/16 | 27/32 | 3 | 2⅛ to 2½ | 20 to 25 |
| 3½ | 19/32 | 9/16 | 1⅞ | 6¾ | 1 1/16 | 15/16 | 3¼ | 2⅝ to 3 | 30 to 40 |
| 3¾ | 21/32 | ⅝ | 2 | 8 | 1¼ | 1 1/16 | 4 | | |
| 4 | 21/32 | ⅝ | 2⅛ | 9 | 1½ | 1 5/16 | 4½ | | |
| 4⅜ | ¾ | 11/16 | 2¼ | | | | | | |

Dimension J to suit requirements.

# Standard Turnbuckles

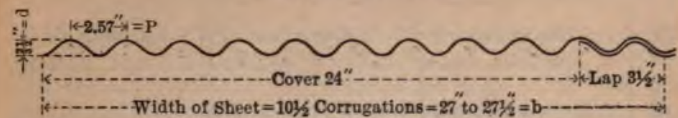
**All Dimensions Given in Inches**




| Size | Clear Distance Between Heads | Length of Tapped Heads | Length of Buckle | Clear Width Inside | Thickness | | Long Diameter | Length | Weight of Buckle, Pounds | Weight of Buckle & Stub Ends, Pounds |
|---|---|---|---|---|---|---|---|---|---|---|
| D | A | B | C | E | F | G | H | L | | |
| $\frac{3}{8}$ | 6 | $\frac{9}{16}$ | $7\frac{1}{8}$ | $\frac{9}{16}$ | $\frac{3}{16}$ | $\frac{1}{2}$ | $1\frac{1}{16}$ | 22 | 1 | $1\frac{1}{2}$ |
| $\frac{7}{16}$ | 6 | $\frac{21}{32}$ | $7\frac{5}{16}$ | $\frac{5}{8}$ | $\frac{1}{4}$ | $\frac{5}{8}$ | $1\frac{3}{8}$ | 22 | 1 | $1\frac{3}{4}$ |
| $\frac{1}{2}$ | 6 | $\frac{3}{4}$ | $7\frac{1}{2}$ | $\frac{5}{8}$ | $\frac{1}{4}$ | $\frac{5}{8}$ | $1\frac{3}{8}$ | 22 | 1 | 2 |
| $\frac{9}{16}$ | 6 | $\frac{27}{32}$ | $7\frac{11}{16}$ | $\frac{13}{16}$ | $\frac{5}{16}$ | $\frac{3}{4}$ | $1\frac{9}{16}$ | 22 | $1\frac{1}{4}$ | $2\frac{1}{2}$ |
| $\frac{5}{8}$ | 6 | $\frac{15}{16}$ | $7\frac{7}{8}$ | $\frac{13}{16}$ | $\frac{5}{16}$ | $\frac{3}{4}$ | $1\frac{9}{16}$ | 22 | $1\frac{1}{2}$ | 3 |
| $\frac{3}{4}$ | 6 | $1\frac{1}{8}$ | $8\frac{1}{4}$ | $1\frac{1}{16}$ | $\frac{11}{32}$ | $\frac{7}{8}$ | 2 | 23 | 2 | 4 |
| $\frac{7}{8}$ | 6 | $1\frac{5}{16}$ | $8\frac{5}{8}$ | $1\frac{1}{4}$ | $\frac{3}{8}$ | 1 | $2\frac{1}{4}$ | 24 | 3 | 6 |
| 1 | 6 | $1\frac{1}{2}$ | 9 | $1\frac{5}{16}$ | $\frac{7}{16}$ | $1\frac{1}{4}$ | $2\frac{7}{16}$ | 25 | 4 | 8 |
| $1\frac{1}{8}$ | 6 | $1\frac{11}{16}$ | $9\frac{3}{8}$ | $1\frac{7}{16}$ | $\frac{1}{2}$ | $1\frac{1}{4}$ | $2\frac{9}{16}$ | 25 | 5 | 11 |
| $1\frac{1}{4}$ | 6 | $1\frac{7}{8}$ | $9\frac{3}{4}$ | $1\frac{9}{16}$ | $\frac{1}{2}$ | $1\frac{1}{2}$ | $2\frac{3}{4}$ | 26 | 6 | 13 |
| $1\frac{3}{8}$ | 6 | $2\frac{1}{16}$ | $10\frac{1}{8}$ | $1\frac{11}{16}$ | $\frac{1}{2}$ | $1\frac{5}{8}$ | $3\frac{1}{16}$ | 27 | 7 | 16 |
| $1\frac{1}{2}$ | 6 | $2\frac{1}{4}$ | $10\frac{1}{2}$ | $1\frac{3}{4}$ | $\frac{5}{8}$ | $1\frac{3}{4}$ | $3\frac{3}{16}$ | 27 | 8 | 19 |
| $1\frac{5}{8}$ | 6 | $2\frac{7}{16}$ | $10\frac{7}{8}$ | 2 | $\frac{5}{8}$ | $1\frac{7}{8}$ | $3\frac{1}{2}$ | 28 | 10 | 23 |
| $1\frac{3}{4}$ | 6 | $2\frac{5}{8}$ | $11\frac{1}{4}$ | $2\frac{1}{8}$ | $\frac{5}{8}$ | 2 | $3\frac{3}{4}$ | 28 | 11 | 26 |
| $1\frac{7}{8}$ | 6 | $2\frac{13}{16}$ | $11\frac{5}{8}$ | $2\frac{3}{16}$ | $\frac{11}{16}$ | $2\frac{1}{8}$ | $3\frac{7}{8}$ | 29 | 12 | 30 |
| 2 | 6 | 3 | 12 | $2\frac{3}{8}$ | $\frac{11}{16}$ | $2\frac{1}{4}$ | $4\frac{1}{4}$ | 29 | 14 | 35 |
| $2\frac{1}{8}$ | 6 | $3\frac{3}{16}$ | $12\frac{3}{8}$ | $2\frac{1}{2}$ | $\frac{23}{32}$ | $2\frac{1}{2}$ | $4\frac{1}{2}$ | 29 | 17 | 41 |
| $2\frac{1}{4}$ | 6 | $3\frac{3}{8}$ | $12\frac{3}{4}$ | $2\frac{11}{16}$ | $\frac{13}{16}$ | $2\frac{1}{2}$ | $4\frac{3}{4}$ | 30 | 20 | 47 |
| $2\frac{3}{8}$ | 6 | $3\frac{9}{16}$ | $13\frac{1}{8}$ | $2\frac{3}{4}$ | $\frac{13}{16}$ | $2\frac{3}{4}$ | $4\frac{7}{8}$ | 31 | 22 | 53 |
| $2\frac{1}{2}$ | 6 | $3\frac{3}{4}$ | $13\frac{1}{2}$ | $3\frac{1}{16}$ | $\frac{27}{32}$ | 3 | $5\frac{3}{8}$ | 32 | 25 | 61 |
| $2\frac{5}{8}$ | 6 | $3\frac{15}{16}$ | $13\frac{7}{8}$ | $3\frac{1}{8}$ | $\frac{15}{16}$ | 3 | $5\frac{9}{16}$ | 32 | 30 | 70 |
| $2\frac{3}{4}$ | 6 | $4\frac{1}{8}$ | $14\frac{1}{4}$ | $3\frac{1}{4}$ | $\frac{15}{16}$ | $3\frac{1}{4}$ | $5\frac{3}{4}$ | 33 | 33 | 78 |
| $2\frac{7}{8}$ | 6 | $4\frac{5}{16}$ | $14\frac{5}{8}$ | $3\frac{7}{16}$ | $1\frac{1}{32}$ | $3\frac{1}{4}$ | $6\frac{1}{16}$ | 33 | 36 | 86 |
| 3 | 6 | $4\frac{1}{2}$ | 15 | $3\frac{5}{8}$ | $1\frac{1}{32}$ | $3\frac{1}{2}$ | $6\frac{3}{8}$ | 34 | 40 | 96 |
| $3\frac{1}{4}$ | 6 | $4\frac{7}{8}$ | $15\frac{3}{4}$ | ..... | ..... | ..... | ..... | 36 | 50 | 120 |
| $3\frac{1}{2}$ | 6 | $5\frac{1}{4}$ | $16\frac{1}{2}$ | ..... | ..... | ..... | ..... | 37 | 65 | 150 |
| $3\frac{3}{4}$ | 6 | $5\frac{5}{8}$ | $17\frac{1}{4}$ | ..... | ..... | ..... | ..... | 39 | ..... | ..... |
| 4 | 6 | 6 | 18 | ..... | ..... | ..... | ..... | 41 | ..... | ..... |
| $4\frac{1}{4}$ | 9 | $6\frac{1}{4}$ | $21\frac{1}{2}$ | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| $4\frac{1}{2}$ | 9 | $6\frac{3}{4}$ | $22\frac{1}{2}$ | | | | | | | |
| $4\frac{3}{4}$ | 9 | $7\frac{1}{4}$ | $23\frac{1}{2}$ | | | | | | | |
| [illegible] | 9 | $7\frac{1}{2}$ | 24 | | | | | | | |

Dimensions E, F, G, H depend upon the specification of the bars with which the turnbuckles are to be used.

# Corrugated Sheets




Note—Allowing a lap of one and one-half corrugations, one sheet will cover 24 inches.

| No. by U. S. Standard Gauge | Thickness in Inches = t | Weight in Pounds | | | | | | Weight per square of 100 sq. ft. of Corrugated Sheets (Black) when laid, allowing 6-inch lap in length and 3½ inches or 1½ corrugations in width of sheet for sheet length of: | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Weights of Sheets Black | | | Weights of Sheets Galvanized | | | | | | | | |
| | | Per Sq. Ft. Flat | Per Sq. Ft. Corrugated | Per Lin. Ft. of Sheet | Per Sq. Ft. Flat | Per Sq. Ft. Corrugated | Per Lin. Ft. of Sheet | 5′ | 6′ | 7′ | 8′ | 9 | 10′ |
| 16 | .0625 | 2.55 | 2.83 | 6.48 | 2.89 | 3.21 | 7.34 | 360 | 353 | 349 | 346 | 343 | 341 |
| 18 | .05 | 2.04 | 2.27 | 5.19 | 2.38 | 2.64 | 6.05 | 288 | 283 | 280 | 277 | 275 | 273 |
| 20 | .0375 | 1.53 | 1.70 | 3.89 | 1.87 | 2.07 | 4.75 | 216 | 212 | 210 | 208 | 206 | 205 |
| 22 | .03125 | 1.275 | 1.42 | 3.24 | 1.62 | 1.79 | 4.10 | 180 | 177 | 175 | 173 | 171 | 170 |
| 24 | .025 | 1.02 | 1.13 | 2.59 | 1.36 | 1.51 | 3.45 | 144 | 142 | 140 | 138 | 137 | 136 |
| 26 | .01875 | 0.765 | 0.85 | 1.94 | 1.11 | 1.22 | 2.80 | 108 | 106 | 105 | 104 | 103 | 102 |

For weight of sheets painted, add 5 to 10 pounds per square of 100 square feet.
For weight of sheets galvanized, add 42 to 46 pounds per square of 100 square feet.
For weight of Clips and Rivets, add 3 per cent of weight of corrugated iron.
For weight per square laid with two laps, add to above 5 per cent.
Sheets are 30½ inches wide before, and 27 to 27½ inches wide after corrugating.
Sheets can be corrugated any length not exceeding 10 feet.
It is not advisable to use over 6′0″ clear spans on roofs.

L = Unsupported length of sheet in inches.
t = Thickness of sheet in inches.
b = Width of sheet in inches.
d = Depth of corrugations in inches.
W = Safe load distributed in pounds.

$$W = \frac{25000\ t\ b\ d}{L}$$

## Standard Steam, Gas and Water Pipe

| Nominal Size, Inches | Ordinary Pipe | | | X Strong Pipe | | | XX Strong Pipe | | |
|---|---|---|---|---|---|---|---|---|---|
| | Inside Diameter | Actual Outside Diameter | Weight per Foot, Pounds | Inside Diameter | Actual Outside Diameter | Weight per Foot, Pounds | Inside Diameter | Actual Outside Diameter | Weight per Foot |
| 1/8 | .27 | .405 | .24 | .205 | .405 | .29 | ...... | ...... | ... |
| 1/4 | .364 | .540 | .42 | .294 | .540 | .54 | ...... | ...... | ... |
| 3/8 | .494 | .675 | .56 | .421 | .675 | .74 | ...... | ...... | ... |
| 1/2 | .623 | .84 | .84 | .542 | .84 | 1.09 | .244 | .84 | 1 |
| 3/4 | .824 | 1.05 | 1.12 | .736 | 1.05 | 1.39 | .422 | 1.05 | 2 |
| 1 | 1.048 | 1.315 | 1.67 | .951 | 1.315 | 2.17 | .587 | 1.315 | 3 |
| 1 1/4 | 1.38 | 1.66 | 2.24 | 1.272 | 1.66 | 3.00 | .885 | 1.66 | 5 |
| 1 1/2 | 1.611 | 1.90 | 2.68 | 1.494 | 1.90 | 3.63 | 1.088 | 1.90 | 6 |
| 2 | 2.067 | 2.375 | 3.61 | 1.933 | 2.375 | 5.02 | 1.491 | 2.375 | 9 |
| 2 1/2 | 2.468 | 2.875 | 5.74 | 2.315 | 2.875 | 7.67 | 1.755 | 2.875 | 13 |
| 3 | 3.067 | 3.50 | 7.54 | 2.892 | 3.50 | 10.25 | 2.284 | 3.50 | 18 |
| 3 1/2 | 3.548 | 4.00 | 9.00 | 3.358 | 4.00 | 12.47 | 2.716 | 4.00 | 22 |
| 4 | 4.026 | 4.50 | 10.66 | 3.818 | 4.50 | 14.97 | 3.136 | 4.50 | 27 |
| 4 1/2 | 4.508 | 5.00 | 12.49 | 4.28 | 5.00 | 18.22 | 3.564 | 5.00 | 32 |
| 5 | 5.045 | 5.563 | 14.50 | 4.813 | 5.563 | 20.54 | 4.063 | 5.563 | 38 |
| 6 | 6.065 | 6.625 | 18.76 | 5.75 | 6.625 | 28.58 | 4.875 | 6.625 | 53 |
| 7 | 7.023 | 7.625 | 23.27 | 6.625 | 7.625 | 37.67 | 5.875 | 7.625 | 62 |
| 8 | 7.982 | 8.625 | 28.18 | 7.625 | 8.625 | 43.00 | 6.875 | 8.625 | 71 |
| 9 | 8.937 | 9.625 | 33.70 | ...... | ...... | ...... | ...... | ...... | ... |
| 10 | 10.019 | 10.75 | 40.00 | ...... | ...... | ...... | ...... | ...... | ... |

## Wooden Beams

The following tables of safe loads for wooden beams are based upon the unit stresses recommended by the American Railway Engineering Association, and are founded upon a unit having a rectangular section one inch thick, the uniformly distributed safe load for which is given in the tables. This is the most convenient arrangement as the safe load for a beam of any width can readily be found by multiplying the tabular value given for the beam one inch wide by the width of the beam for which the safe load is desired.

These loads, as given, include the weights of the beams themselves and it is assumed that the beams will be so braced as to secure them against lateral or side deflection.

There will also be found in these tables the maximum and minimum spans on which these beams should be used and the co-efficients of deflection.

The maximum load that it has been considered safe to put on these beams is that load which is indicated by the maximum allowable shearing stress along the horizontal axis of the beam. This is given by the formula—maximum safe load equals four times area of section divided by three times safe unit stress for longitudinal shear.

These limits which are indicated by horizontal lines in the tables, should not be exceeded. This will avoid the failure of the beam in a direction parallel to the grain of the wood. Usually this is in the horizontal.

The deflection under a uniformly distributed load at the center of the span is obtained by dividing the coefficient of deflection by the depth of the beam in inches. This deflection considers loads that are permanently applied only and will approximate the actual deflection, but owing to the modulus of elasticity of the material varying with the amount of moisture contained, it cannot be considered as more than approximate. It is usually considered well to limit the deflection to 1/360 of the span where plastered ceilings are involved. This limit will also be found indicated in the tables.

For concentrated loads at center of span one-half of the tabular values should be used and four-fifths of the deflection coefficient.

## Working Stresses per Square Inch for Structural Timber

The stresses per square inch, as given in this table, are based upon the stresses recommended by the American Railway Engineering Association for railroad structures.

For highway structures the stresses can be safely increased about one-fourth, while for buildings and similar structures, where the timber is protected from the effects of the weather and where the load is practically steady, these unit stresses can safely be increased by one-half.

Where beams remain under load for long continued periods only fifty per cent of the corresponding modulus of elasticity need be used in computing the deflection.

### Unit Stresses in Pounds Per Square Inch

| Kind of Timber | Bending: Extreme Fiber Stress, Average Ultimate | Bending: Extreme Fiber Stress, Working Stress | Bending: Modulus of Elasticity, Average | Shearing: Parallel to the Grain, Average Ultimate | Shearing: Parallel to the Grain, Working Stress | Shearing: Longitudinal Shear in Beams, Average Ultimate | Shearing: Longitudinal Shear in Beams, Working Stress | Compression: Perpendicular to the Grain, Elastic Limit | Compression: Perpendicular to the Grain, Working Stress | Compression: Parallel to the Grain, Average Ultimate | Compression: Parallel to the Grain, Working Stress | Compression: Working Stresses for Columns, Length under 15xd | Compression: Working Stresses for Columns, Length over 15xd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Douglas Fir.... | 6100 | 1200 | 1510000 | 690 | 170 | 270 | 110 | 630 | 310 | 3600 | 1200 | 900 | $1200\left(1-\frac{1}{60d}\right)$ |
| Longleaf Pine.. | 6500 | 1300 | 1610000 | 720 | 180 | 300 | 120 | 520 | 260 | 3800 | 1300 | 975 | $1300\left(1-\frac{1}{60d}\right)$ |
| Shortleaf Pine.. | 5600 | 1100 | 1480000 | 710 | 170 | 330 | 130 | 340 | 170 | 3400 | 1100 | 825 | $1100\left(1-\frac{1}{60d}\right)$ |
| White Pine.... | 4400 | 900 | 1130000 | 400 | 100 | 180 | 70 | 290 | 150 | 3000 | 1000 | 750 | $1000\left(1-\frac{1}{60d}\right)$ |

## *Unit Stresses in Pounds per Square Inch*—Continued

| Kind of Timber | Bending | | | Shearing | | | | Compression | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Extreme Fiber Stress | | Modulus of Elasticity | Parallel to the Grain | | Longitudinal Shear in Beams | | Perpendicular to the Grain | | Parallel to the Grain | | Working Stresses for Columns | |
| | Average Ultimate | Working Stress | Average | Average Ultimate | Working Stress | Average Ultimate | Working Stress | Elastic Limit | Working Stress | Average Ultimate | Working Stress | Length under 15xd | Length over 15xd |
| Spruce | 4800 | 1000 | 1310000 | 600 | 150 | 170 | 70 | 370 | 180 | 3200 | 1100 | 825 | $1100\left(1-\frac{l}{60d}\right)$ |
| Norway Pine | 4200 | 800 | 1190000 | 590* | 130 | 250 | 100 | ..... | 150 | 2600* | 800 | 600 | $800\left(1-\frac{l}{60d}\right)$ |
| Tamarack | 4600 | 900 | 1220000 | 670 | 170 | 260 | 100 | ..... | 220 | 3200* | 1000 | 750 | $1000\left(1-\frac{l}{60d}\right)$ |
| Western Hemlock | 5800 | 1100 | 1480000 | 630 | 160 | 270* | 100 | 440 | 220 | 3500 | 1200 | 900 | $1200\left(1-\frac{l}{60d}\right)$ |
| Redwood | 5000 | 900 | 800000 | 300 | 80 | ..... | ..... | 400 | 150 | 3300 | 900 | 675 | $900\left(1-\frac{l}{60d}\right)$ |
| Bald Cypress | 4800 | 900 | 1150000 | 500 | 120 | ..... | ..... | 340 | 170 | 3900 | 1100 | 825 | $1100\left(1-\frac{l}{60d}\right)$ |
| Red Cedar | 4200 | 800 | 800000 | ..... | ..... | ..... | ..... | 470 | 230 | 2800 | 900 | 675 | $900\left(1-\frac{l}{60d}\right)$ |
| White Oak | 5700 | 1100 | 1150000 | 840 | 210 | 270 | 110 | 920 | 450 | 3500 | 1300 | 975 | $1300\left(1-\frac{l}{60d}\right)$ |

Unit stresses are for green timber and are to be used without increasing the live load stresses for impact. Values noted * are partially air dry timbers.

In the formulae given for columns, l = length of column, in inches, and d = least side or diameter, in inches.

# Wooden Beams

## Examples of Use of Tables

Example 1.—Required the thickness and the approximate deflection of a beam of white pine, 16 inches deep, supporting a uniformly distributed and permanent dead and live load of 13000 pounds over a span of 20 feet.

The tabular value for a beam one inch thick and for a span of 20 feet is 1280 pounds; the required thickness is therefore 13000 ÷ 1280 = 10 inches, and the deflection is 19.09 ÷ 16 = 1.19 inches.

Example 2.—Required the safe load of a beam of white oak 10 inches deep and 8 inches thick, without exceeding the longitudinal shearing stress.

The table gives for a corresponding beam 1 inch thick a safe load of 1467 pounds; the total safe load is therefore 8 × 1467 = 11736 pounds, or the safe load which can be safely supported over a span of 8.3 feet.

Example 3.—Required the safe load, concentrated in the center of a span 25 feet long and the deflection of a beam of spruce 20 inches deep and 16 inches thick.

The table gives for a corresponding beam 1 inch thick a uniformly distributed safe load of 1422 pounds, or for a load in center of span 1778 ÷ 2 = 889 pounds; for a beam 16 inches wide the safe load is therefore 889 × 16 = 14224 pounds, and the deflection is approximately 4/5 × 28.63 ÷ 20 = 1.15 inches.

# Rectangular Wooden Beams—One Inch Thick

## Greatest Safe Loads and Span Limits

| Depth of Beam, Inches | White Oak | | Longleaf Pine | | Shortleaf Pine | | White Pine | | Douglas Fir | | Western Hemlock | | Spruce | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. | Max. Load, Lbs. | Min. Span, Ft. |
| 2 | 293 | 1.7 | 320 | 1.8 | 347 | 1.5 | 187 | 2.1 | 293 | 1.8 | 267 | 1.8 | 187 | 2.4 |
| 4 | 587 | 3.3 | 640 | 3.6 | 693 | 3.1 | 373 | 4.3 | 587 | 3.6 | 533 | 3.7 | 373 | 4.8 |
| 6 | 880 | 5.0 | 960 | 5.4 | 1040 | 4.6 | 560 | 6.4 | 880 | 5.5 | 800 | 5.5 | 560 | 7.1 |
| 8 | 1173 | 6.7 | 1280 | 7.2 | 1387 | 6.2 | 747 | 8.6 | 1173 | 7.3 | 1067 | 7.3 | 747 | 9.5 |
| 10 | 1467 | 8.3 | 1600 | 9.0 | 1733 | 7.7 | 933 | 10.7 | 1467 | 9.1 | 1333 | 9.2 | 933 | 11.9 |
| 12 | 1760 | 10.0 | 1920 | 10.8 | 2080 | 9.2 | 1120 | 12.9 | 1760 | 10.9 | 1600 | 11.0 | 1120 | 14.3 |
| 14 | 2053 | 11.7 | 2240 | 12.6 | 2427 | 10.8 | 1307 | 15.0 | 2053 | 12.7 | 1867 | 12.8 | 1307 | 16.7 |
| 16 | 2347 | 13.3 | 2560 | 14.4 | 2773 | 12.3 | 1493 | 17.1 | 2347 | 14.5 | 2133 | 14.7 | 1493 | 19.0 |
| 18 | 2640 | 15.0 | 2880 | 16.3 | 3120 | 13.8 | 1680 | 19.3 | 2640 | 16.4 | 2400 | 16.5 | 1680 | 21.4 |
| 20 | 2933 | 16.7 | 3200 | 18.1 | 3467 | 15.4 | 1867 | 21.4 | 2933 | 18.2 | 2667 | 18.3 | 1867 | 23.8 |
| 22 | 3227 | 18.3 | 3520 | 19.9 | 3813 | 16.9 | 2053 | 23.6 | 3227 | 20.0 | 2933 | 20.2 | 2053 | 26.2 |
| 24 | 3520 | 20.0 | 3840 | 21.7 | 4160 | 18.5 | 2240 | 25.7 | 3520 | 21.8 | 3200 | 22.0 | 2240 | 28.6 |

## Coefficients of Deflection for Constant Loading

| Span in Feet | White Oak | Longleaf Pine | Shortleaf Pine, Western Hemlock | White Pine, Douglas Fir | Spruce | Span in Feet | White Oak | Longleaf Pine | Shortleaf Pine, Western Hemlock | White Pine, Douglas Fir | Spruce |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 21 | 25.31 | 21.37 | 19.67 | 21.05 | 20.20 |
| 2 | 0.23 | 0.19 | 0.18 | 0.19 | 0.18 | 22 | 27.78 | 23.44 | 21.59 | 23.10 | 22.17 |
| 3 | 0.52 | 0.44 | 0.40 | 0.43 | 0.41 | 23 | 30.37 | 25.63 | 23.59 | 25.25 | 24.23 |
| 4 | 0.92 | 0.78 | 0.71 | 0.76 | 0.73 | 24 | 33.06 | 27.91 | 25.69 | 27.49 | 26.38 |
| 5 | 1.44 | 1.21 | 1.12 | 1.19 | 1.15 | 25 | 35.88 | 30.28 | 27.88 | 29.83 | 28.63 |
| 6 | 2.07 | 1.74 | 1.61 | 1.72 | 1.65 | 26 | 38.80 | 32.75 | 30.15 | 32.27 | 30.96 |
| 7 | 2.81 | 2.37 | 2.19 | 2.34 | 2.24 | 27 | 41.85 | 35.32 | 32.51 | 34.80 | 33.39 |
| 8 | 3.67 | 3.10 | 2.85 | 3.06 | 2.93 | 28 | 45.00 | 37.99 | 34.97 | 37.42 | 35.91 |
| 9 | 4.65 | 3.92 | 3.61 | 3.87 | 3.71 | 29 | 48.27 | 40.75 | 37.51 | 40.14 | 38.52 |
| 10 | 5.74 | 4.85 | 4.46 | 4.77 | 4.58 | 30 | 51.66 | 43.61 | 40.14 | 42.96 | 41.22 |
| 11 | 6.95 | 5.86 | 5.40 | 5.78 | 5.54 | 31 | 55.16 | 46.56 | 42.86 | 45.87 | 44.01 |
| 12 | 8.27 | 6.98 | 6.42 | 6.87 | 6.60 | 32 | 58.78 | 49.61 | 45.67 | 48.88 | 46.90 |
| 13 | 9.70 | 8.19 | 7.54 | 8.07 | 7.74 | 33 | 62.51 | 52.76 | 48.57 | 51.98 | 49.88 |
| 14 | 11.25 | 9.50 | 8.74 | 9.36 | 8.98 | 34 | 66.35 | 56.01 | 51.56 | 55.18 | 52.95 |
| 15 | 12.92 | 10.90 | 10.04 | 10.74 | 10.31 | 35 | 70.32 | 59.35 | 54.64 | 58.47 | 56.11 |
| 16 | 14.69 | 12.40 | 11.42 | 12.22 | 11.73 | 36 | 74.39 | 62.79 | 57.80 | 61.86 | 59.36 |
| 17 | 16.59 | 14.00 | 12.89 | 13.79 | 13.24 | 37 | 78.58 | 66.33 | 61.06 | 65.34 | 62.70 |
| 18 | 18.60 | 15.70 | 14.45 | 15.47 | 14.84 | 38 | 82.89 | 69.96 | 64.40 | 68.92 | 66.14 |
| 19 | 20.72 | 17.49 | 16.10 | 17.23 | 16.53 | 39 | 87.31 | 73.69 | 67.84 | 72.60 | 69.66 |
| 20 | 22.96 | 19.38 | 17.84 | 19.09 | 18.32 | 40 | 91.84 | 77.52 | 71.36 | 76.37 | 73.28 |

## Greatest Span in Feet for Constant Loading

| Species of Timber | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| White Oak | 2.3 | 4.7 | 7.0 | 9.3 | 11.6 | 13.9 | 16.3 | 18.6 | 20.9 | 23.2 | 25.6 | 27.9 |
| Longleaf Pine | 2.8 | 5.5 | 8.3 | 11.0 | 13.8 | 16.5 | 19.3 | 22.0 | 24.8 | 27.6 | 30.3 | 33.1 |
| Shortleaf Pine | 3.0 | 6.0 | 9.0 | 12.0 | 15.0 | 17.9 | 20.9 | 23.9 | 26.9 | 29.9 | 32.9 | 35.9 |
| Western Hemlock | 3.0 | 6.0 | 9.0 | 12.0 | 15.0 | 17.9 | 20.9 | 23.9 | 26.9 | 29.9 | 32.9 | 35.9 |
| White Pine, Douglas Fir | 2.8 | 5.6 | 8.4 | 11.2 | 14.0 | 16.7 | 19.5 | 22.3 | 25.1 | 27.9 | 30.7 | 34.5 |
| Spruce | 2.9 | 5.8 | 8.7 | 11.6 | 14.6 | 17.5 | 20.4 | 23.3 | 26.2 | 29.[illegible] | [illegible] | [illegible] |

# Rectangular Wooden Beams—One Inch Thick

**Continued**

## Douglas Fir

Allowable uniform loads in pounds.
Extreme fibre stress, 1200 pounds per square inch.

| Span in Feet | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 2 | 293<br>267 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 3 | 178 | 587 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 4 | 133 | 533 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | 107 | 427 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6 | 89 | 356 | 880<br>800 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7 | 76 | 305 | 686 | 1173 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8 | 67 | 267 | 600 | 1067 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 9 | ...... | 237 | 533 | 948 | 1467 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 10 | ...... | 213 | 480 | 853 | 1333 | ...... | ...... | ...... | ...... | ...... | ...... | .... |
| 11 | ...... | 194 | 436 | 776 | 1212 | 1760<br>1745 | ...... | ...... | ...... | ...... | ...... | ...... |
| 12 | ...... | 178 | 400 | 711 | 1111 | 1600 | 2053 | ...... | ...... | ...... | ...... | ...... |
| 13 | ...... | ...... | 369 | 656 | 1026 | 1477 | 2010 | ...... | ...... | ...... | ...... | ...... |
| 14 | ...... | ...... | 343 | 610 | 952 | 1371 | 1867 | 2347 | ...... | ...... | ...... | ...... |
| 15 | ...... | ...... | 320 | 569 | 889 | 1280 | 1742 | 2276 | ...... | ...... | ...... | ...... |
| 16 | ...... | ...... | 300 | 533 | 833 | 1200 | 1633 | 2133 | 2640 | ...... | ...... | ...... |
| 17 | ...... | ...... | ...... | 502 | 784 | 1129 | 1537 | 2008 | 2541 | ...... | ...... | ...... |
| 18 | ...... | ...... | ...... | 474 | 741 | 1067 | 1452 | 1896 | 2400 | 2933 | ...... | ...... |
| 19 | ...... | ...... | ...... | 449 | 702 | 1011 | 1375 | 1796 | 2274 | 2807 | 3227 | ...... |
| 20 | ...... | ...... | ...... | 427 | 667 | 960 | 1307 | 1707 | 2160 | 2667 | 3227 | ...... |
| 21 | ...... | ...... | ...... | ...... | 635 | 914 | 1244 | 1625 | 2057 | 2540 | 3073 | 3520 |
| 22 | ...... | ...... | ...... | ...... | 606 | 873 | 1188 | 1552 | 1964 | 2424 | 2933 | 3491 |
| 23 | ...... | ...... | ...... | ...... | 580 | 835 | 1136 | 1484 | 1878 | 2319 | 2806 | 3339 |
| 24 | ...... | ...... | ...... | ...... | 556 | 800 | 1089 | 1422 | 1800 | 2222 | 2689 | 3200 |
| 25 | ...... | ...... | ...... | ...... | ...... | 768 | 1045 | 1365 | 1728 | 2133 | 2581 | 3072 |
| 26 | ...... | ...... | ...... | ...... | ...... | 738 | 1005 | 1313 | 1662 | 2051 | 2482 | 2954 |
| 27 | ...... | ...... | ...... | ...... | ...... | 711 | 968 | 1264 | 1600 | 1975 | 2390 | 2844 |
| 28 | ...... | ...... | ...... | ...... | ...... | 686 | 933 | 1219 | 1543 | 1905 | 2305 | 2743 |
| 29 | ...... | ...... | ...... | ...... | ...... | ...... | 901 | 1177 | 1490 | 1839 | 2225 | 2648 |
| 30 | ...... | ...... | ...... | ...... | ...... | ...... | 871 | 1138 | 1440 | 1778 | 2151 | 2560 |
| 31 | ...... | ...... | ...... | ...... | ...... | ...... | 843 | 1101 | 1394 | 1720 | 2082 | 2477 |
| 32 | ...... | ...... | ...... | ...... | ...... | ...... | 817 | 1067 | 1350 | 1667 | 2017 | 2400 |
| 33 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1034 | 1309 | 1616 | 1956 | 2327 |
| 34 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1004 | 1271 | 1569 | 1898 | 2259 |
| 35 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 975 | 1234 | 1524 | 1844 | 2194 |
| 36 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 948 | 1200 | 1481 | 1793 | 2133 |
| 37 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1168 | 1441 | 1744 | 2076 |
| 38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1137 | 1404 | 1698 | 2021 |
| 39 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1108 | 1368 | 1655 | 1969 |
| 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1080 | 1333 | 1613 | 1920 |

*Horizontal lines* indicate the limit for shear in the direction of the grain.

# Rectangular Wooden Beams—One Inch Thick

**Continued**

## Longleaf Pine

Allowable uniform loads in pounds.
Extreme fibre stress, 1300 pounds per square inch.

| Span in Feet | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 2 | 320 / 289 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 3 | 193 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 4 | 144 | 640 / 578 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | 116 | 462 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6 | 96 | 385 | 960 / 867 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7 | 83 | 330 | 743 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8 | 72 | 289 | 650 | 1280 / 1156 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 9 | ...... | 257 | 578 | 1027 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 10 | ...... | 231 | 520 | 924 | 1600 / 1444 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 11 | ...... | 210 | 473 | 840 | 1313 | 1920 / 1891 | ...... | ...... | ...... | ...... | ...... | ...... |
| 12 | ...... | 193 | 433 | 770 | 1204 | 1733 | ...... | ...... | ...... | ...... | ...... | ...... |
| 13 | ...... | ...... | 400 | 711 | 1111 | 1600 | 2240 / 2178 | ...... | ...... | ...... | ...... | ...... |
| 14 | ...... | ...... | 371 | 660 | 1032 | 1486 | 2022 | ...... | ...... | ...... | ...... | ...... |
| 15 | ...... | ...... | 347 | 616 | 963 | 1387 | 1887 | 2560 / 2465 | ...... | ...... | ...... | ...... |
| 16 | ...... | ...... | 325 | 578 | 903 | 1300 | 1769 | 2311 | ...... | ...... | ...... | ...... |
| 17 | ...... | ...... | ...... | 544 | 850 | 1224 | 1665 | 2175 | 2880 / 2753 | ...... | ...... | ...... |
| 18 | ...... | ...... | ...... | 514 | 802 | 1156 | 1573 | 2054 | 2600 | ...... | ...... | ...... |
| 19 | ...... | ...... | ...... | 487 | 760 | 1095 | 1490 | 1946 | 2463 | 3200 / 3041 | ...... | ...... |
| 20 | ...... | ...... | ...... | 462 | 722 | 1040 | 1416 | 1849 | 2340 | 2889 | 3520 / 3496 | ...... |
| 21 | ...... | ...... | ...... | ...... | 688 | 991 | 1348 | 1761 | 2229 | 2751 | 3329 | ...... |
| 22 | ...... | ...... | ...... | ...... | 657 | 945 | 1287 | 1681 | 2127 | 2626 | 3178 | 3840 / 3782 |
| 23 | ...... | ...... | ...... | ...... | 628 | 904 | 1231 | 1608 | 2035 | 2512 | 3040 | 3617 |
| 24 | ...... | ...... | ...... | ...... | 602 | 867 | 1180 | 1541 | 1950 | 2407 | 2913 | 3467 |
| 25 | ...... | ...... | ...... | ...... | ...... | 832 | 1132 | 1479 | 1872 | 2311 | 2796 | 3328 |
| 26 | ...... | ...... | ...... | ...... | ...... | 800 | 1089 | 1422 | 1800 | 2222 | 2689 | 3200 |
| 27 | ...... | ...... | ...... | ...... | ...... | 770 | 1049 | 1370 | 1733 | 2140 | 2589 | 3082 |
| 28 | ...... | ...... | ...... | ...... | ...... | 743 | 1011 | 1321 | 1671 | 2064 | 2497 | 2971 |
| 29 | ...... | ...... | ...... | ...... | ...... | ...... | 976 | 1275 | 1614 | 1992 | 2411 | 2869 |
| 30 | ...... | ...... | ...... | ...... | ...... | ...... | 944 | 1233 | 1560 | 1926 | 2330 | 2773 |
| 31 | ...... | ...... | ...... | ...... | ...... | ...... | 913 | 1193 | 1510 | 1864 | 2255 | 2684 |
| 32 | ...... | ...... | ...... | ...... | ...... | ...... | 885 | 1156 | 1463 | 1806 | 2185 | 2600 |
| 33 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1121 | 1418 | 1751 | 2119 | 2521 |
| 34 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1088 | 1377 | 1699 | 2056 | 2447 |
| 35 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1057 | 1337 | 1651 | 1998 | 2377 |
| 36 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1027 | 1300 | 1605 | 1942 | 2311 |
| 37 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1265 | 1562 | 1890 | 2249 |
| 38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1232 | 1521 | 1840 | 2189 |
| 39 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1200 | 1482 | 1793 | 2133 |
| 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1170 | 1444 | 1748 | 2080 |

Horizontal lines indicate the limit for shear in the direction of the grain

# Rectangular Wooden Beams—One Inch Thick

**Continued**

## Shortleaf Pine, Western Hemlock and White Oak

Allowable uniform loads in pounds.
Extreme fibre stress, 1100 pounds per square inch.

| Span in Feet | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 2 | 347<br>245 | 693 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 3 | 163 | 652 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 4 | 122 | 489 | 1040 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | 98 | 391 | 880 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6 | 82 | 326 | 733 | 1387<br>1304 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7 | 70 | 279 | 629 | 1117 | 1733 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8 | 61 | 245 | 550 | 978 | 1528 | 2080 | ...... | ...... | ...... | ...... | ...... | ...... |
| 9 | ...... | 217 | 489 | 869 | 1358 | 1956 | 2427 | ...... | ...... | ...... | ...... | ...... |
| 10 | ...... | 196 | 440 | 782 | 1222 | 1760 | 2396 | ...... | ...... | ...... | ...... | ...... |
| 11 | ...... | 178 | 400 | 711 | 1111 | 1600 | 2178 | 2773 | ...... | ...... | ...... | ...... |
| 12 | ...... | 163 | 367 | 652 | 1019 | 1467 | 1996 | 2607 | 3120 | ...... | ...... | ...... |
| 13 | ...... | ...... | 338 | 602 | 940 | 1354 | 1843 | 2407 | 3046 | ...... | ...... | ...... |
| 14 | ...... | ...... | 314 | 559 | 873 | 1257 | 1711 | 2235 | 2829 | 3467 | ...... | ...... |
| 15 | ...... | ...... | 293 | 522 | 816 | 1173 | 1597 | 2086 | 2640 | 3259 | ...... | ...... |
| 16 | ...... | ...... | 275 | 489 | 764 | 1100 | 1497 | 1956 | 2475 | 3055 | 3813<br>3697 | 4160 |
| 17 | ...... | ...... | ...... | 460 | 719 | 1035 | 1409 | 1841 | 2329 | 2876 | 3480 | 4141 |
| 18 | ...... | ...... | ...... | 435 | 679 | 978 | 1331 | 1738 | 2200 | 2716 | 3287 | 3911 |
| 19 | ...... | ...... | ...... | 412 | 643 | 926 | 1261 | 1647 | 2084 | 2573 | 3113 | 3705 |
| 20 | ...... | ...... | ...... | 391 | 611 | 880 | 1198 | 1564 | 1980 | 2444 | 2958 | 3520 |
| 21 | ...... | ...... | ...... | ...... | 583 | 838 | 1141 | 1490 | 1886 | 2328 | 2817 | 3352 |
| 22 | ...... | ...... | ...... | ...... | 556 | 800 | 1089 | 1422 | 1800 | 2222 | 2689 | 3200 |
| 23 | ...... | ...... | ...... | ...... | 531 | 765 | 1042 | 1361 | 1722 | 2126 | 2572 | 3061 |
| 24 | ...... | ...... | ...... | ...... | 509 | 733 | 998 | 1304 | 1650 | 2037 | 2465 | 2933 |
| 25 | ...... | ...... | ...... | ...... | ...... | 704 | 958 | 1252 | 1584 | 1956 | 2366 | 2816 |
| 26 | ...... | ...... | ...... | ...... | ...... | 677 | 921 | 1203 | 1523 | 1880 | 2275 | 2708 |
| 27 | ...... | ...... | ...... | ...... | ...... | 652 | 887 | 1159 | 1467 | 1811 | 2191 | 2608 |
| 28 | ...... | ...... | ...... | ...... | ...... | 629 | 856 | 1118 | 1414 | 1746 | 2113 | 2514 |
| 29 | ...... | ...... | ...... | ...... | ...... | ...... | 826 | 1079 | 1366 | 1686 | 2040 | 2428 |
| 30 | ...... | ...... | ...... | ...... | ...... | ...... | 799 | 1043 | 1320 | 1630 | 1973 | 2348 |
| 31 | ...... | ...... | ...... | ...... | ...... | ...... | 773 | 1009 | 1278 | 1577 | 1908 | 2271 |
| 32 | ...... | ...... | ...... | ...... | ...... | ...... | 749 | 978 | 1238 | 1528 | 1849 | 2200 |
| 33 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 948 | 1200 | 1482 | 1793 | 2133 |
| 34 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 920 | 1165 | 1438 | 1740 | 2071 |
| 35 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 894 | 1131 | 1397 | 1690 | 2011 |
| 36 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 869 | 1100 | 1358 | 1643 | 1956 |
| 37 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1070 | 1321 | 1599 | 1903 |
| 38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1042 | 1287 | 1557 | 1853 |
| 39 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1015 | 1254 | 1517 | 1805 |
| 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 990 | 1222 | 1479 | 1760 |

*Upper, middle* and lower horizontal lines indicate the limits for shear in the *ection of the* grain of Shortleaf Pine, White Oak and Hemlock respectively.

# Rectangular Wooden Beams—One Inch Thick

Continued

## White Pine

Allowable uniform loads in pounds.
Extreme fibre stress, 900 pounds per square inch.

| Span in Feet | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 2 | 187 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 3 | 133 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 4 | 100 | 373 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | 80 | 320 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6 | 67 | 267 | 560 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7 | 57 | 229 | 514 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8 | 50 | 200 | 450 | 747 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 9 | ...... | 178 | 400 | 711 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 10 | ...... | 160 | 360 | 640 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 11 | ...... | 145 | 327 | 582 | 933 / 909 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 12 | ...... | 133 | 300 | 533 | 833 | 1120 | ...... | ...... | ...... | ...... | ...... | ...... |
| 13 | ...... | ...... | 277 | 492 | 769 | 1108 | ...... | ...... | ...... | ...... | ...... | ...... |
| 14 | ...... | ...... | 257 | 457 | 714 | 1029 | 1307 | ...... | ...... | ...... | ...... | ...... |
| 15 | ...... | ...... | 240 | 427 | 667 | 960 | 1307 | ...... | ...... | ...... | ...... | ...... |
| 16 | ...... | ...... | 225 | 400 | 625 | 900 | 1225 | ...... | ...... | ...... | ...... | ...... |
| 17 | ...... | ...... | ...... | 377 | 588 | 847 | 1153 | 1493 | ...... | ...... | ...... | ...... |
| 18 | ...... | ...... | ...... | 356 | 556 | 800 | 1089 | 1422 | ...... | ...... | ...... | ...... |
| 19 | ...... | ...... | ...... | 337 | 526 | 758 | 1032 | 1347 | 1680 | ...... | ...... | ...... |
| 20 | ...... | ...... | ...... | 320 | 500 | 720 | 980 | 1280 | 1620 | ...... | ...... | ...... |
| 21 | ...... | ...... | ...... | ...... | 476 | 686 | 933 | 1219 | 1543 | 1867 | ...... | ...... |
| 22 | ...... | ...... | ...... | ...... | 455 | 655 | 891 | 1164 | 1473 | 1818 | ...... | ...... |
| 23 | ...... | ...... | ...... | ...... | 435 | 626 | 852 | 1113 | 1409 | 1739 | 2053 | ...... |
| 24 | ...... | ...... | ...... | ...... | 417 | 600 | 817 | 1067 | 1350 | 1667 | 2017 | ...... |
| 25 | ...... | ...... | ...... | ...... | ...... | 576 | 784 | 1024 | 1296 | 1600 | 1936 | ...... |
| 26 | ...... | ...... | ...... | ...... | ...... | 554 | 754 | 985 | 1246 | 1538 | 1862 | 2240 / 2215 |
| 27 | ...... | ...... | ...... | ...... | ...... | 533 | 726 | 948 | 1200 | 1481 | 1793 | 2133 |
| 28 | ...... | ...... | ...... | ...... | ...... | 514 | 700 | 914 | 1157 | 1429 | 1729 | 2057 |
| 29 | ...... | ...... | ...... | ...... | ...... | ...... | 676 | 883 | 1117 | 1379 | 1669 | 1986 |
| 30 | ...... | ...... | ...... | ...... | ...... | ...... | 653 | 853 | 1080 | 1333 | 1613 | 1920 |
| 31 | ...... | ...... | ...... | ...... | ...... | ...... | 632 | 826 | 1045 | 1290 | 1561 | 1858 |
| 32 | ...... | ...... | ...... | ...... | ...... | ...... | 613 | 800 | 1013 | 1250 | 1513 | 1800 |
| 33 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 776 | 982 | 1212 | 1467 | 1746 |
| 34 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 753 | 953 | 1176 | 1424 | 1694 |
| 35 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 731 | 926 | 1143 | 1383 | 1646 |
| 36 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 711 | 900 | 1111 | 1344 | 1600 |
| 37 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 876 | 1081 | 1308 | 1557 |
| 38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 853 | 1053 | 1274 | 1516 |
| 39 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 831 | 1026 | 1241 | 1477 |
| 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 810 | 1000 | 1210 | 1440 |

Horizontal lines indicate the limit for shear in the direction of th

# Rectangular Wooden Beams—One Inch Thick

**Continued**

## Spruce

Allowable uniform loads in pounds.
Extreme fibre stress, 1000 pounds per square inch.

| Span in Feet | Depth of Beam in Inches | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 2 | 187 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 3 | 148 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 4 | 111 | 373 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5 | 89 | 356 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 6 | 74 | 296 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 7 | 63 | 254 | 560 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 8 | 56 | 222 | 500 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 9 | ...... | 198 | 444 | 747 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 10 | ...... | 178 | 400 | 711 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 11 | ...... | 162 | 364 | 646 | 933 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 12 | ...... | 148 | 333 | 593 | 926 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 13 | ...... | ...... | 308 | 547 | 855 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 14 | ...... | ...... | 286 | 508 | 794 | 1120 | ...... | ...... | ...... | ...... | ...... | ...... |
| 15 | ...... | ...... | 267 | 474 | 741 | 1067 | ...... | ...... | ...... | ...... | ...... | ...... |
| 16 | ...... | ...... | 250 | 444 | 694 | 1000 | 1307 | ...... | ...... | ...... | ...... | ...... |
| 17 | ...... | ...... | ...... | 418 | 654 | 941 | 1281 | ...... | ...... | ...... | ...... | ...... |
| 18 | ...... | ...... | ...... | 395 | 617 | 889 | 1210 | ...... | ...... | ...... | ...... | ...... |
| 19 | ...... | ...... | ...... | 374 | 585 | 842 | 1146 | 1493 | ...... | ...... | ...... | ...... |
| 20 | ...... | ...... | ...... | 356 | 556 | 800 | 1089 | 1422 | ...... | ...... | ...... | ...... |
| 21 | ...... | ...... | ...... | ...... | 529 | 762 | 1037 | 1354 | 1680 | ...... | ...... | ...... |
| 22 | ...... | ...... | ...... | ...... | 505 | 727 | 990 | 1293 | 1636 | ...... | ...... | ...... |
| 23 | ...... | ...... | ...... | ...... | 483 | 696 | 947 | 1237 | 1565 | 1867 | ...... | ...... |
| 24 | ...... | ...... | ...... | ...... | 463 | 667 | 907 | 1185 | 1500 | 1852 | ...... | ...... |
| 25 | ...... | ...... | ...... | ...... | ...... | 640 | 871 | 1138 | 1440 | 1778 | ...... | ...... |
| 26 | ...... | ...... | ...... | ...... | ...... | 615 | 838 | 1094 | 1385 | 1709 | 2053 | ...... |
| 27 | ...... | ...... | ...... | ...... | ...... | 593 | 807 | 1053 | 1333 | 1646 | 1992 | ...... |
| 28 | ...... | ...... | ...... | ...... | ...... | 571 | 778 | 1016 | 1286 | 1587 | 1921 | 2240 |
| 29 | ...... | ...... | ...... | ...... | ...... | ...... | 751 | 981 | 1241 | 1533 | 1854 | 2207 |
| 30 | ...... | ...... | ...... | ...... | ...... | ...... | 726 | 948 | 1200 | 1481 | 1793 | 2133 |
| 31 | ...... | ...... | ...... | ...... | ...... | ...... | 703 | 918 | 1161 | 1434 | 1735 | 2065 |
| 32 | ...... | ...... | ...... | ...... | ...... | ...... | 681 | 889 | 1125 | 1389 | 1681 | 2000 |
| 33 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 862 | 1091 | 1347 | 1630 | 1939 |
| 34 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 837 | 1059 | 1307 | 1582 | 1882 |
| 35 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 813 | 1029 | 1270 | 1537 | 1829 |
| 36 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 790 | 1000 | 1235 | 1494 | 1778 |
| 37 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 973 | 1201 | 1453 | 1730 |
| 38 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 947 | 1169 | 1415 | 1684 |
| 39 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 923 | 1140 | 1379 | 1641 |
| 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 900 | 1111 | 1344 | 1600 |

Horizontal lines indicate the limit for shear in the direction of the grain.

# Wooden Posts

The following tables of safe loads for wooden posts are based on the working stresses per square inch recommended by the American Railway Engineering Association, and give the recommended direct compressive load for both round and square posts.

For rectangular posts other than square, the safe loads may be found from the tables giving safe loads for the square posts by increasing the tabular load in direct proportion to the areas of the respective posts. The square post used for purposes of comparison should of course be the square whose side is equal to the least side of the rectangular section that it is proposed to use.

The table below gives the safe load in pounds per square inch of sectional area for posts having ratio of length to least side, or diameter ranging between 15 and 30.

Example—Required the allowable load for a post of white pine 6″x8″, 10 ft. long. The safe load as per table for the white pine post 6″x6″, 10 ft. long, is given as 18900 pounds. The load for the 6″x8″ section would therefore be 8/6 of this or 25200 pounds.

## Working Stresses in Pounds Per Square Inch

| $\frac{l}{d}$ | Longleaf Pine, White Oak | Douglas Fir, Western Hemlock | Shortleaf Pine, Spruce, Bald Cypress | White Pine, Tamarack | Red Cedar, Redwood | Norway Pine |
|---|---|---|---|---|---|---|
| | $1300(1-\frac{l}{60d})$ | $1200(1-\frac{l}{60d})$ | $1100(1-\frac{l}{60d})$ | $1000(1-\frac{l}{60d})$ | $900(1-\frac{l}{60d})$ | $800(1-\frac{l}{60d})$ |
| 15 | 975 | 900 | 825 | 750 | 675 | 600 |
| 16 | 953 | 880 | 807 | 733 | 660 | 587 |
| 17 | 931 | 860 | 788 | 717 | 645 | 573 |
| 18 | 910 | 840 | 770 | 700 | 630 | 560 |
| 19 | 888 | 820 | 752 | 683 | 615 | 547 |
| 20 | 867 | 800 | 733 | 667 | 600 | 533 |
| 21 | 845 | 780 | 715 | 650 | 585 | 520 |
| 22 | 823 | 760 | 697 | 633 | 570 | 507 |
| 23 | 802 | 740 | 678 | 617 | 555 | 493 |
| 24 | 780 | 720 | 660 | 600 | 540 | 480 |
| 25 | 758 | 700 | 642 | 583 | 525 | 467 |
| 26 | 737 | 680 | 623 | 567 | 510 | 453 |
| 27 | 715 | 660 | 605 | 550 | 495 | 440 |
| 28 | 693 | 640 | 587 | 533 | 480 | 427 |
| 29 | 672 | 620 | 568 | 517 | 465 | 413 |
| 30 | 650 | 600 | 550 | 500 | 450 | 400 |

# Square Wooden Posts

## Safe Loads in Thousands of Pounds

American Railway Engineering Association Formulae.

| | Length, Feet | Side of Square, Inches 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **LONGLEAF PINE WHITE OAK** $1300\left(1-\frac{l}{60d}\right)$ | | 15.6 | | | | | | | | |
| | 5 | 15.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 14.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 13.5 | 35.1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 12.5 | 34.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 11.4 | 32.8 | 62.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 10.4 | 31.2 | 62.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 29.6 | 60.3 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 28.1 | 58.2 | 97.5 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 25.0 | 54.1 | 93.6 | 140.4 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 49.9 | 88.4 | 137.3 | 191.1 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 45.8 | 83.2 | 131.0 | 189.3 | 249.6 | ...... | ...... |
| | 20 | ...... | ...... | 41.6 | 78.0 | 124.8 | 182.0 | 249.6 | 315.9 | 390.0 |
| **DOUGLAS FIR WESTERN HEMLOCK** $1200\left(1-\frac{l}{60d}\right)$ | | 14.4 | | | | | | | | |
| | 5 | 14.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 13.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 12.5 | 32.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 11.5 | 31.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 10.6 | 30.2 | 57.6 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 9.6 | 28.8 | 57.6 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 27.4 | 55.7 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 25.9 | 53.8 | 90.0 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 23.0 | 49.9 | 86.4 | 129.6 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 46.1 | 81.6 | 126.7 | 176.4 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 42.2 | 76.8 | 121.0 | 174.7 | 230.4 | ...... | ...... |
| | 20 | ...... | ...... | 38.4 | 72.0 | 115.2 | 168.0 | 230.4 | 291.6 | 360.0 |
| **SHORTLEAF PINE SPRUCE** $1100\left(1-\frac{l}{60d}\right)$ | | 13.2 | | | | | | | | |
| | 5 | 13.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 12.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 11.4 | 29.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 10.6 | 29.0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 9.7 | 27.7 | 52.8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 8.8 | 26.4 | 52.8 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 25.1 | 51.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 23.8 | 49.3 | 82.5 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 21.1 | 45.8 | 79.2 | 118.8 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 42.2 | 74.8 | 116.2 | 161.7 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 38.7 | 70.4 | 110.9 | 160.2 | 211.2 | ...... | ...... |
| | 20 | ...... | ...... | 35.2 | 66.0 | 105.6 | 154.0 | 211.2 | 267.3 | 330.0 |
| **WHITE PINE TAMARACK** $1000\left(1-\frac{l}{60d}\right)$ | | 12.0 | | | | | | | | |
| | 5 | 12.0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 11.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 10.4 | 27.0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 9.6 | 26.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 8.8 | 25.2 | 48.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 8.0 | 24.0 | 48.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 22.8 | 46.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 21.6 | 44.8 | 75.0 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 19.2 | 41.6 | 72.0 | 108.0 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 38.4 | 68.0 | 105.6 | 147.0 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 35.2 | 64.0 | 100.8 | 145.6 | 192.0 | ...... | ...... |
| | 20 | ...... | ...... | 32.0 | 60.0 | 96.0 | 140.0 | 192.0 | 243.0 | 300.0 |

*Figures above horizontal lines indicate greatest permissible loading.*

# Round Wooden Posts

## Safe Loads in Thousands of Pounds

American Railway Engineering Association Formulae.

| | Length, Feet | Diameter, Inches 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **LONGLEAF PINE WHITE OAK** $1300\left(1-\frac{l}{60d}\right)$ | | 12.3 | | | | | | | | |
| | 5 | 12.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 11.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 10.6 | 27.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 9.8 | 27.0 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 9.0 | 25.7 | 49.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 8.2 | 24.5 | 49.0 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 23.3 | 47.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 22.1 | 45.7 | 76.6 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 19.6 | 42.5 | 73.5 | 110.3 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 39.2 | 69.4 | 107.8 | 150.1 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 35.9 | 65.3 | 102.9 | 148.7 | 196.0 | ...... | ...... |
| | 20 | ...... | ...... | 32.7 | 61.3 | 98.0 | 142.9 | 196.0 | 248.1 | 306.3 |
| **DOUGLAS FIR WESTERN HEMLOCK** $1200\left(1-\frac{l}{60d}\right)$ | | 11.3 | | | | | | | | |
| | 5 | 11.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 10.6 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 9.8 | 25.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 9.1 | 24.9 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 8.3 | 23.7 | 45.2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 7.5 | 22.6 | 45.2 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 21.5 | 43.7 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 20.4 | 42.2 | 70.7 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 18.1 | 39.2 | 67.9 | 101.8 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 36.2 | 64.1 | 99.5 | 138.5 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 33.2 | 60.3 | 95.0 | 137.2 | 181.0 | ...... | ...... |
| | 20 | ...... | ...... | 30.2 | 56.5 | 90.5 | 132.0 | 181.0 | 229.0 | 282.7 |
| **SHORTLEAF PINE SPRUCE** $1100\left(1-\frac{l}{60d}\right)$ | | 10.4 | | | | | | | | |
| | 5 | 10.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 9.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 9.0 | 23.3 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 8.3 | 22.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 7.6 | 21.8 | 41.5 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 6.9 | 20.7 | 41.5 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 19.7 | 40.1 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 18.7 | 38.7 | 64.8 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 16.6 | 35.9 | 62.2 | 93.3 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 33.2 | 58.7 | 91.2 | 127.0 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 30.4 | 55.3 | 87.1 | 125.8 | 165.9 | ...... | ...... |
| | 20 | ...... | ...... | 27.6 | 51.8 | 82.9 | 121.0 | 165.9 | 209.9 | 259.2 |
| **WHITE PINE TAMARACK** $1000\left(1-\frac{l}{60d}\right)$ | | 9.4 | | | | | | | | |
| | 5 | 9.4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 6 | 8.8 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 7 | 8.2 | 21.2 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 8 | 7.5 | 20.7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| | 9 | 6.9 | 19.8 | 37.7 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 10 | 6.3 | 18.9 | 37.7 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 11 | ...... | 17.9 | 36.4 | ...... | ...... | ...... | ...... | ...... | ...... |
| | 12 | ...... | 17.0 | 35.2 | 58.9 | ...... | ...... | ...... | ...... | ...... |
| | 14 | ...... | 15.1 | 32.7 | 56.5 | 84.8 | ...... | ...... | ...... | ...... |
| | 16 | ...... | ...... | 30.2 | 53.4 | 82.9 | 115.5 | ...... | ...... | ...... |
| | 18 | ...... | ...... | 27.6 | 50.3 | 79.2 | 114.4 | 150.8 | ...... | [illegible] |
| | 20 | ...... | ...... | 25.1 | 47.1 | 75.4 | 110.0 | 150.8 | 190.5 | [illegible] |

Figures above horizontal lines indicate greatest permissible loading.

## Weights of Various Materials and Loads for Storage Warehouses

| Material Stored | Weights per Cubic Foot of Space, Pounds | Height of Pile, Feet | Weights per Square Foot of Floor, Pounds | Recommended Live Loads, Pounds per Square Foot |
|---|---|---|---|---|
| **Groceries, Wines, Liquors, Etc.** | | | | |
| Beans, in bags | 40 | 8 | 320 | 250 to 300 |
| Canned Goods, in cases | 58 | 6 | 348 | |
| Coffee, Roasted, in bags | 33 | 8 | 264 | |
| Coffee, Green, in bags | 39 | 8 | 312 | |
| Dates, in cases | 55 | 6 | 330 | |
| Figs, in cases | 74 | 5 | 370 | |
| Flour, in barrels | 40 | 5 | 200 | |
| Molasses, in barrels | 48 | 5 | 240 | |
| Rice, in bags | 58 | 6 | 348 | |
| Sal Soda, in barrels | 46 | 5 | 230 | |
| Salt, in bags | 70 | 5 | 350 | |
| Soap Powder, in cases | 38 | 8 | 304 | |
| Starch, in barrels | 25 | 6 | 150 | |
| Sugar, in barrels | 43 | 5 | 215 | |
| Sugar, in cases | 51 | 6 | 306 | |
| Tea, in chests | 25 | 8 | 200 | |
| Wines and Liquors, in barrels | 38 | 6 | 228 | |
| **Dry Goods, Cotton, Wool, Etc.** | | | | |
| Burlap, in bales | 43 | 6 | 258 | 200 to 250 |
| Coir Yarn, in bales | 33 | 8 | 264 | |
| Cotton, in bales, compressed | 18 | 8 | 144 | |
| Cotton Bleached Goods, in cases | 28 | 8 | 224 | |
| Cotton Flannel, in cases | 12 | 8 | 96 | |
| Cotton Sheeting, in cases | 23 | 8 | 184 | |
| Cotton Yarn, in cases | 25 | 8 | 200 | |
| Excelsior, compressed | 19 | 8 | 152 | |
| Hemp, Italian, compressed | 22 | 8 | 176 | |
| Hemp, Manila, compressed | 30 | 8 | 240 | |
| Jute, compressed | 41 | 8 | 328 | |

*Continued on next page.*

# Weights of Various Materials and Loads for Storage Warehouses

Continued

| Material Stored | Weights per Cubic Foot of Space, Pounds | Height of Pile, Feet | Weights per Square Foot of Floor, Pounds | Recommended Live Loads, Pounds per Square Foot |
|---|---|---|---|---|
| **y Goods, Cotton, Wool, Etc.** | | | | |
| Continued | | | | |
| ı Damask, in cases.. | 50 | 5 | 250 | 200 to 250 |
| ı Goods, in cases... | 30 | 8 | 240 | |
| ı Towels, in cases... | 40 | 6 | 240 | |
| , compressed....... | 21 | 8 | 168 | |
| compressed........ | 29 | 8 | 232 | |
| , in bales, compressed.............. | 48 | ........ | ........ | |
| , in bales, not compressed.............. | 13 | 8 | 104 | |
| , Worsteds, in cases. | 27 | 8 | 216 | |
| **uilding Materials** | | | | |
| ent, Natural........ | 59 | 6 | 354 | 300 to 400 |
| ent, Portland....... | 73 | 6 | 438 | |
| and Plaster....... | 53 | 5 | 265 | |
| **Hardware, Etc.** | | | | |
| Checks........... | 45 | ........ | ........ | 300 to 400 |
| es................. | 64 | ........ | ........ | |
| s, in cases, packed.. | 31 | ........ | ........ | |
| Fasteners.......... | 48 | ........ | ........ | |
| ws................ | 101 | ........ | ........ | |
| t Tin, in boxes...... | 278 | 2 | 556 | |
| Cables, on reels.... | ........ | ........ | 425 | |
| , Insulated Copper, coils.............. | 63 | 5 | 315 | |
| , Galvanized Iron, in ls.................. | 74 | 4½ | 333 | |
| , Magnet, on spools. | 75 | 6 | 450 | |

ntinued on next page.

# Weights of Various Materials and Loads for Storage Warehouses

Continued

| Material Stored | Weights per Cubic Foot of Space, Pounds | Height of Pile, Feet | Weights per Square Foot of Floor, Pounds | Recommended Live Loads, Pounds per Square Foot |
|---|---|---|---|---|
| **Drugs, Paints, Oil, Etc.** | | | | |
| Alum, Pearl, in barrels | 33 | 6 | 198 | |
| Bleaching Powder, in hogsheads | 31 | 3½ | 102 | |
| Blue Vitriol, in barrels | 45 | 5 | 226 | |
| Glycerine, in cases | 52 | 6 | 312 | |
| Linseed Oil, in barrels | 36 | 6 | 216 | |
| Linseed Oil, in iron drums | 45 | 4 | 180 | |
| Logwood Extract, in boxes | 70 | 5 | 350 | |
| Rosin, in barrels | 48 | 6 | 288 | 200 to 300 |
| Shellac, Gum | 38 | 6 | 228 | |
| Soda Ash, in hogsheads | 62 | 2¾ | 167 | |
| Soda, Caustic, in iron drums | 88 | 3⅓ | 294 | |
| Soda, Silicate, in barrels | 53 | 6 | 318 | |
| Sulphuric Acid | 60 | 1⅔ | 100 | |
| White Lead Paste, in cans | 174 | 3½ | 610 | |
| White Lead, dry | 86 | 4¾ | 408 | |
| Red Lead and Litharge, dry | 132 | 3¾ | 495 | |
| **Miscellaneous** | | | | |
| Glass and Chinaware, in crates | 40 | 8 | 320 | |
| Hides and Leather, in bales | 20 | 8 | 160 | |
| Hides, Buffalo, in bundles | 37 | 8 | 296 | |
| Paper, Newspaper, and Strawboards | 35 | 6 | 210 | 300 |
| Paper, Writing and Calendered | 60 | 6 | 360 | |
| Rope, in coils | 32 | 6 | 192 | |

# Expansion of Bodies by Heat

The linear coefficient of expansion of a body is the rate at which the unit of length changes, under constant pressure, with an increase of unit or one degree of temperature. The square surface coefficient of expansion is, approximately, two times and the cubical or volumetric coefficient three times the linear coefficient of expansion. A bar, if not fixed, undergoes a change in length = $ltn$, where $l$ is the length of the bar in inches, $t$ the number of degrees and $n$ the corresponding linear coefficient. If fixed at both ends, the internal stress per unit of area = $tnE$, pounds per square inch, where $E$ is the modulus of elasticity, and the total temperature stress = $AtnE$, pounds, where $A$ is the cross section of the bar in square inches.

To find the increase of a bar due to an increase in temperature, from the following table, multiply the number of degrees by the coefficient given for 100 degrees and divide by 100.

Co-efficients of Expansion for 100 Degrees = $100n$

| Substance | Linear Expansion | | Substance | Linear Expansion | |
|---|---|---|---|---|---|
| | Centigrade | Fahrenheit | | Centigrade | Fahrenheit |
| **Metals and Alloys** | | | **Stone and Masonry** | | |
| Aluminum, wrought | .00231 | .00128 | Ashlar masonry | .00063 | .00035 |
| Brass | .00188 | .00104 | Brick masonry | .00055 | .00031 |
| " wire | .00193 | .00107 | Cement, Portland | .00107 | .00059 |
| Bronze | .00181 | .00101 | Concrete | .00143 | .00079 |
| Copper | .00168 | .00093 | " masonry | .00120 | .00067 |
| German Silver | .00183 | .00102 | Granite | .00084 | .00047 |
| Gold | .00150 | .00083 | Limestone | .00080 | .00044 |
| Iron, cast, gray | .00106 | .00059 | Marble | .00100 | .00056 |
| " wrought | .00120 | .00067 | Plaster | .00166 | .00092 |
| " wire | .00124 | .00069 | Rubble masonry | .00063 | .00035 |
| Lead | .00286 | .00159 | Sandstone | .00110 | .00061 |
| Nickel | .00126 | .00070 | Slate | .00104 | .00058 |
| Platinum | .00090 | .00050 | **Timber** | | |
| Platinum-Iridium, 15% Ir | .00081 | .00045 | Fir, parallel to fiber | .00037 | .00021 |
| Silver | .00192 | .00107 | Maple, parallel to fiber | .00064 | .00036 |
| Steel, cast | .00110 | .00061 | Oak, parallel to fiber | .00049 | .00027 |
| " hard | .00132 | .00073 | Pine, parallel to fiber | .00054 | .00030 |
| " medium | .00120 | .00067 | Fir, perpendicular to fiber | .0058 | .0032 |
| " soft | .00110 | .00061 | Maple, perpendicular to fiber | .0048 | .0027 |
| Tin | .00210 | .00117 | Oak, perpendicular to fiber | .0054 | .0030 |
| Zinc, rolled | .00311 | .00173 | Pine, perpendicular to fiber | .0034 | .0019 |
| **Miscellaneous Solids** | | | **Liquid Substances** | Volumetric Expansion | |
| Glass | .00085 | .00047 | Alcohol | .104 | .058 |
| Graphite | .00079 | .00044 | Acid, nitric | .110 | .061 |
| Gutta-percha | .05980 | .03322 | " sulphuric | .063 | .035 |
| Paraffin | .02785 | .01547 | Mercury | .018 | .010 |
| Porcelain | .00036 | .00020 | Oil, turpentine | .090 | .050 |

Expansion of Water, Maximum Density = 1.

| C° | Volume | C° | Volume | C° | Volume | C° | Volume | C° | Volume | C° | Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1.000126 | 10 | 1.000257 | 30 | 1.004234 | 50 | 1.011877 | 70 | 1.022384 | 90 | [illegible] |
| 4 | 1.000000 | 20 | 1.001732 | 40 | 1.007627 | 60 | 1.016954 | 80 | 1.029003 | 100 | [illegible] |

# Weight and Specific Gravity

## Various Materials

Water at 39.2° F.

| Substance | Specific Gravity | Weight per Cu. Ft. Lbs. |
|---|---|---|
| **Metals, Alloys, Ores** | | |
| Aluminum, cast-hammered | 2.55-2.75 | 165 |
| Aluminum, bronze | 7.7 | 481 |
| Brass, cast-rolled | 8.4-8.7 | 534 |
| Bronze, 7.9 to 14% Sn | 7.4-8.9 | 509 |
| Copper, cast-rolled | 8.8-9.0 | 556 |
| " ore, pyrites | 4.1-4.3 | 262 |
| Gold, cast-hammered | 19.25-19.35 | 1205 |
| Iron, cast, pig | 7.2 | 450 |
| " wrought | 7.6-7.9 | 485 |
| " steel | 7.8-7.9 | 490 |
| " Spiegel-Eisen | 7.5 | 468 |
| " ferro-silicon | 6.7-7.3 | 437 |
| " ore, hematite | 5.2 | 325 |
| " " limonite | 3.6-4.0 | 237 |
| " " magnetite | 4.9-5.2 | 315 |
| " slag | 2.5-3.0 | 172 |
| Lead | 11.37 | 710 |
| " ore, Galena | 7.3-7.6 | 465 |
| Manganese | 7.2-8.0 | 475 |
| " ore, pyrolusite | 3.7-4.6 | 259 |
| Mercury | 13.6 | 849 |
| Nickel | 8.9-9.2 | 565 |
| " monel metal | 8.8-9.0 | 556 |
| Platinum, cast-hammered | 21.1-21.5 | 1330 |
| Silver, cast-hammered | 10.4-10.6 | 656 |
| Tin, cast-hammered | 7.2-7.5 | 459 |
| " ore, cassiterite | 6.4-7.0 | 418 |
| Zinc, cast-rolled | 6.9-7.2 | 440 |
| " ore, blende | 3.9-4.2 | 253 |
| **Various Solids** | | |
| Cereals, oats, bulk | .......... | 32 |
| " barley, bulk | .......... | 39 |
| " corn, rye, bulk | .......... | 48 |
| " wheat, bulk | .......... | 48 |
| Hay and Straw, bales | .......... | 20 |
| Cotton, Flax, Hemp | 1.47-1.50 | 93 |
| Fats | 0.90-0.97 | 58 |
| Flour, loose | 0.40-0.50 | 28 |
| " pressed | 0.70-0.80 | 47 |
| Glass, common | 2.40-2.60 | 156 |
| " plate or crown | 2.45-2.72 | 161 |
| " crystal | 2.90-3.00 | 184 |

| Substance | Specific Gravity | Weight per Cu. Ft. Lbs. |
|---|---|---|
| **Various Solids Continued** | | |
| Leather | 0.86-1.02 | 59 |
| Paper | 0.70-1.15 | 58 |
| Potatoes, piled | .......... | 42 |
| Rubber, caoutchouc | 0.92-0.96 | 59 |
| Rubber goods | 1.0-2.0 | 94 |
| Salt, granulated, piled | .77 | 48 |
| Saltpeter | 1.07 | 67 |
| Starch | 1.53 | 96 |
| Sulphur | 1.93-2.07 | 125 |
| Wool | 1.32 | 82 |
| **Timber, U. S. Seasoned** | | |
| Ash, white-red | 0.62-0.65 | 40 |
| Cedar, white-red | 0.32-0.38 | 22 |
| Chestnut | 0.66 | 41 |
| Cypress | 0.48 | 30 |
| Fir, Douglas spruce | 0.51 | 32 |
| " eastern | 0.40 | 25 |
| Elm, white | 0.72 | 45 |
| Hemlock | 0.42-0.52 | 29 |
| Hickory | 0.74-0.84 | 49 |
| Locust | 0.73 | 46 |
| Maple, hard | 0.68 | 43 |
| " white | 0.53 | 33 |
| Oak, chestnut | 0.86 | 54 |
| " live | 0.95 | 59 |
| " red, black | 0.65 | 41 |
| " white | 0.74 | 46 |
| Pine, Oregon | 0.51 | 32 |
| " red | 0.48 | 30 |
| " white | 0.41 | 26 |
| " yellow, longleaf | 0.70 | 44 |
| " " shortleaf | 0.61 | 38 |
| Poplar | 0.48 | 30 |
| Redwood, California | 0.42 | 26 |
| Spruce, white, black | 0.40-0.46 | 27 |
| Walnut, black | 0.61 | 38 |
| " white | 0.41 | 26 |
| MOISTURE CONTENTS: Seasoned timber 15 to 20% | | |
| Green timber up to 50% | | |

ntinued on next page.

# Weight and Specific Gravity

## Various Materials

**Continued**

Water at 39.2° F.

| Substance | Specific Gravity | Weight per Cu. Ft. Lbs. |
|---|---|---|
| **Various Liquids** | | |
| Alcohol, 100% | 0.79 | 49 |
| Acids, muriatic...40% | 1.20 | 75 |
| " nitric......91% | 1.50 | 94 |
| " sulphuric..87% | 1.80 | 112 |
| Lye, soda.........66% | 1.70 | 106 |
| Oils, vegetable | 0.91-0.94 | 58 |
| " mineral, lubricants | 0.90-0.93 | 57 |
| Water, 4°C, max. density | 1.0 | 62.428 |
| " 100°C | 0.9584 | 59.830 |
| " ice | 0.88-0.92 | 56 |
| " snow, fresh fallen | .125 | 8 |
| " sea water | 1.02-1.03 | 64 |
| **Gases, Air=1** | | |
| Air, 0°C, 760 mm | 1.0 | 1/773 |
| Ammonia | 0.5920 | ...... |
| Carbon dioxide | 1.5291 | ...... |
| Carbon monoxide | 0.9673 | ...... |
| Gas, illuminating | 0.35-0.45 | ...... |
| " natural | 0.47-0.48 | ...... |
| Hydrogen | 0.0693 | ...... |
| Nitrogen | 0.9714 | ...... |
| Oxygen | 1.1056 | ...... |
| **Ashlar Masonry** | | |
| Granite, syenite, gneiss | 2.3-3.0 | 165 |
| Limestone, marble | 2.3-2.8 | 160 |
| Sandstone, bluestone | 2.1-2.4 | 140 |
| **Mortar Rubble Masonry** | | |
| Granite, syenite, gneiss | 2.2-2.8 | 155 |
| Limestone, marble | 2.2-2.6 | 150 |
| Sandstone, bluestone | 2.0-2.2 | 130 |
| **Dry Rubble Masonry** | | |
| Granite, syenite, gneiss | 1.9-2.3 | 130 |
| Limestone, marble | 1.9-2.1 | 125 |
| Sandstone, bluestone | 1.8-1.9 | 110 |

| Substance | Specific Gravity | Weight per Cu. Ft., Lbs. |
|---|---|---|
| **Brick Masonry** | | |
| Pressed brick | 2.2-2.3 | 140 |
| Common brick | 1.8-2.0 | 120 |
| Soft brick | 1.5-1.7 | 100 |
| **Concrete Masonry** | | |
| Cement, stone, sand | 2.2-2.4 | 144 |
| " slag, etc | 1.9-2.3 | 130 |
| " cinder, etc | 1.5-1.7 | 100 |
| **Various Building Material** | | |
| Ashes, cinders | ........ | 40-45 |
| Cement, Portland, loose | ........ | 90 |
| Cement, Portland, set | 2.7-3.2 | 183 |
| Lime, gypsum, loose | ........ | 53-64 |
| Mortar, set | 1.4-1.9 | 103 |
| Slags, bank slag | ........ | 67-72 |
| " bank screenings | ........ | 98-117 |
| " machine slag | ........ | 96 |
| " slag sand | ........ | 49-55 |
| **Excavated Earth, Etc.,** | | |
| Clay, dry | ........ | 63 |
| " damp, plastic | ........ | 110 |
| Clay and gravel, dry | ........ | 100 |
| Earth, dry, loose | ........ | 76 |
| " dry, packed | ........ | 95 |
| " moist, loose | ........ | 78 |
| " moist, packed | ........ | 96 |
| " mud, flowing | ........ | 108 |
| " mud, packed | ........ | 115 |
| Riprap, limestone | ........ | 80-85 |
| " sandstone | ........ | 90 |
| " shale | ........ | 105 |
| Sand, gravel, dry, loose | ........ | 90-105 |
| " " " packed | ........ | 100-120 |
| " " " wet | ........ | 118-120 |

Continued on next page.

# Weight and Specific Gravity

## Various Materials

**Continued**

Water at 39.2° F.

| Substance | Specific Gravity | Weight, per Cu. Ft. Lbs. |
|---|---|---|
| **Excavations in Water** | | |
| Sand or gravel | ........ | 60 |
| Sand or gravel and clay | ........ | 65 |
| Clay | ........ | 80 |
| River mud | ........ | 90 |
| Soil | ........ | 70 |
| Stone riprap | ........ | 65 |
| **Minerals** | | |
| Asbestos | 2.1-2.8 | 153 |
| Barytes | 4.50 | 281 |
| Basalt | 2.7-3.2 | 184 |
| Bauxite | 2.55 | 159 |
| Borax | 1.7-1.8 | 109 |
| Chalk | 1.8-2.6 | 137 |
| Clay, marl | 1.8-2.6 | 137 |
| Dolomite | 2.9 | 181 |
| Feldspar, orthoclase | 2.5-2.6 | 159 |
| Gneiss, serpentine | 2.4-2.7 | 159 |
| Granite, syenite | 2.5-3.1 | 175 |
| Greenstone, trap | 2.8-3.2 | 187 |
| Gypsum, alabaster | 2.3-2.8 | 159 |
| Hornblende | 3.0 | 187 |
| Limestone, marble | 2.5-2.8 | 165 |
| Magnesite | 3.0 | 187 |
| Phosphate rock apatite | 3.2 | 200 |
| Porphyry | 2.6-2.9 | 172 |
| Pumice, natural | 0.37-0.90 | 40 |
| Quartz, flint | 2.5-2.8 | 165 |
| Sandstone, bluestone | 2.2-2.5 | 147 |
| Shale, slate | 2.7-2.9 | 175 |
| Soapstone, talc | 2.6-2.8 | 169 |

| Substance | Specific Gravity | Weight per Cu. Ft. Lbs. |
|---|---|---|
| **Stone, Quarried, Piled** | | |
| Basalt, granite gneiss | ........ | 96 |
| Limestone, marble, quartz | ........ | 95 |
| Sandstone | ........ | 82 |
| Shale | ........ | 92 |
| Greenstone, hornblende | ........ | 107 |
| **Bituminous Substances** | | |
| Asphaltum | 1.1-1.5 | 81 |
| Coal, anthracite | 1.4-1.7 | 97 |
| " bituminous | 1.2-1.5 | 84 |
| " lignite | 1.1-1.4 | 78 |
| " peat, turf, dry | 0.65-0.85 | 47 |
| " charcoal, pine | 0.28-0.44 | 23 |
| " " oak | 0.47-0.57 | 33 |
| " coke | 1.0-1.4 | 75 |
| Graphite | 1.9-2.3 | 131 |
| Paraffine | 0.87-0.91 | 56 |
| Petroleum | 0.87 | 54 |
| " refined | 0.79-0.82 | 50 |
| " benzine | 0.73-0.75 | 46 |
| " gasoline | 0.66-0.69 | 42 |
| Pitch | 1.07-1.15 | 69 |
| Tar, bituminous | 1.20 | 75 |
| **Coal and Coke, Piled** | | |
| Coal, anthracite | ........ | 47-58 |
| " bituminous, lignite | ........ | 40-54 |
| " peat, turf | ........ | 20-26 |
| " charcoal | ........ | 10-14 |
| " coke | ........ | 23-32 |

# Strength of Materials

## Stresses Per Square Inch

| Metals and Alloys | Stresses in Thousands of Pounds: Tension, Ultimate | Elastic Limit | Compression, Ultimate | Bending, Ultimate | Shearing, Ultimate | Modulus of Elasticity, Pounds | Elongation, % |
|---|---|---|---|---|---|---|---|
| Aluminum, cast | 15 | 6.5 | 12 | | 12 | 11,000,000 | |
| " bars, sheets | 24–28 | 12–14 | | | | | |
| " wire, hard | 30–65 | 16–30 | | | | | |
| " wire, annealed | 20–35 | 14 | | | | | |
| " Bronze, 5% to 7½% Alumin. | 75 | 40 | 120 | | | | |
| " " 10% Aluminum | 85–100 | 60 | | | | | |
| Copper, cast | 25 | 6 | 40 | 22 | 30 | 10,000,000 | |
| " plates, rods, bolts | 32–35 | 10 | 32 | | | | |
| " wire, hard | 55–65 | | | | | 18,000,000 | |
| " wire, annealed | 36 | 10 | | | | 15,000,000 | |
| Brass, 17% Zinc | 32.6 | 8.2 | | 23.2 | | | 26.7 |
| " 23% " | | 7.6 | 42 | 22.3 | | | 35.8 |
| " 30% " | 28.1 | 8.6 | | 26.9 | | | 20.7 |
| " 39% " | 41.1 | 17.4 | 75 | 39 | | | 20.7 |
| " 50% " | 31 | 17.9 | 117 | 33.5 | | | 5.0 |
| " cast, common | 18–24 | 6 | 30 | 20 | 36 | 9,000,000 | |
| " wire, hard | 80 | | | | | | |
| " wire, annealed | 50 | 16 | | | | 14,000,000 | |
| Bronze 8% Tin | 28.5 | 19 | 42 | 43.7 | | 10,000,000 | 5.5 |
| " 13% " | 29.4 | 20 | 53 | 34.5 | | | 3.3 |
| " 20% " | 33 | | 78 | 56.7 | | | 0.04 |
| " 24% " | 22 | 22 | 114 | 32 | | | 0. |
| " 30% " | 5.6 | 5.6 | 147 | 12.1 | | | 0. |
| " gun metal, 9 Copper, 1 Tin | 25–55 | 10 | | 52 | | 10,000,000 | |
| " Manganese, cast (10% Tin, 2% Mn.) | 60 | 30 | 125 | | | | |
| " " rolled (10% Tin, 2% Mn.) | 100 | 80 | | | | | |
| " Phosphorus, cast (9% Tin, 1% Phos.) | 50 | 24 | | | | | |
| " " wire (9% Tin, 1% Phos.) | 100 | | | | | | |
| " Silicon, cast, 3% Silicon | 55 | | | | | | |
| " " " 5% Silicon | 75 | | | | | | |
| " " wire | 108 | | | | | | |
| " Tobin, cast (38% Zinc, 1½% Tin, ⅓% Lead) | 66 | | | | | | |
| " " rolled (38% Zinc, 1½% Tin, ⅓% Lead) | 80 | 40 | | | | 4,500,000 | |
| " " cold rolled (38% Zinc, 1½% Tin, ⅓% Lead) | 100 | | | | | | |
| Delta Metal, cast (55—60% Copper, 38—40% Zinc, 2—4% Iron, 1—2% Tin) | 45 | | | | | | |
| " " plates | 68 | | | | | | |
| " " bars | 85 | | | | | | |
| " " wire | 100 | | | | | | |
| German Silver, 25% Zinc, 20% Nickel | | | | | | | |
| Gold, cast | 20 | 4 | | | | 8,000,000 | |
| " wire | 30 | | | | | | |
| " copper, 5 gold, 1 copper | 50 | | | | | | |
| Lead, cast | 1.8 | | | | | 1,000,000 | |
| " pipe, wire | 2.2-2.5 | | | | | 1,000,000 | |
| " rolled sheets | 3.3 | | | | | 720,000 | |
| Platinum, wire, unannealed | 53 | | | | | | |
| " " annealed | 32 | | | | | | |
| Silver, cast | 40 | | | | | | |
| Tin, cast | 3.5-4.6 | 1.5-1.8 | 6 | 4 | | 4,000,000 | |
| " antimony, 10 tin, 1 antimony | 11 | | | | | | |
| Zinc, cast | 4–6 | 4 | 18 | 7 | | 13,000,000 | |
| " rolled sheets | 7–16 | | | | | | |

# Strength of Materials
### Continued
## Stresses in Pounds per Square Inch

| Building Materials | Average Ultimate Stresses | | | Modulus of Elasticity | Safe Working Stresses | | |
|---|---|---|---|---|---|---|---|
| | Compress. | Tension | Bending | | Compress. | Bearing | Shearing |
| **Stone** | | | | | | | |
| Bluestone | 12,000 | 1,200 | 2,500 | 7,000,000 | 1,200 | 1,200 | 200 |
| Granite, gneiss | 12,000 | 1,200 | 1,600 | 7,000,000 | 1,200 | 1,200 | 200 |
| Limestone, marble | 8,000 | 800 | 1,500 | 7,000,000 | 800 | 800 | 150 |
| Sandstone | 5,000 | 150 | 1,200 | 3,000,000 | 500 | 500 | 150 |
| Slate | 10,000 | 3,000 | 5,000 | 14,000,000 | 1,000 | 1,000 | 175 |
| **Brick** | | | | | | | |
| Common, good | 10,000 | 200 | 600 | | | | |
| " medium burned | 11,000 | | | | | | |
| " hard burned | 15,000 | | | | | | |
| Pressed and paving | 6,000 | | | | | | |
| **Cement, Portland** | | | | | | | |
| Neat, 28 days | 7,040 | 740 | | | | | |
| " 90 days | 7,350 | 740 | | | | | |
| 1:3 sand, 28 days | 1,290 | 320 | | | | | |
| " 90 days | 1,490 | 340 | | | | | |
| **Concrete, P. C.** | | | | | | | |
| 1:1½:3, hard stone | 2,650 | | | | | | |
| " soft stone | 1,800 | | | | | | |
| " cinders | 700 | | | | | | |
| 1:2:4, hard stone | 2,100 | | | | | | |
| " soft stone | 1,500 | | | | | | |
| " cinders | 600 | | | | | | |
| 1:2½:5, hard stone | 1,700 | | | | | | |
| " soft stone | 1,200 | | | | | | |
| " cinders | 500 | | | | | | |
| 1:3:6, hard stone | 1,350 | | | | | | |
| " soft stone | 1,000 | | | | | | |
| " cinders | 400 | | | | | | |
| **Masonry** | | | | | | | |
| Granite | | | | | 420 | 600 | |
| Limestone, bluestone | | | | | 350 | 500 | |
| Sandstone | | | | | 280 | 400 | |
| Rubble | | | | | 140 | 250 | |
| " coursed | | | | | 168 | 250 | |
| Concrete, P.C., 1:2:4 | | | | | 350 | 600 | |
| " " 1:2½:5 | | | | | 280 | 500 | |
| Brick, common | | | | | 168 | 300 | |
| " hard burned | | | | | 210 | 300 | |
| **Miscellaneous** | | | | | | | |
| Glass, common | 30,000 | 3,000 | 3,000 | 8,000,000 | | | |
| " flooring | 10,000 | 3,000 | 3,000 | | | | |
| Plaster | 700 | 70 | | | | | |
| Terra cotta | 5,000 | | | | | | |
| Ropes, cast steel hoist | | 80,000 | | | | | |
| Ropes, standing, der'k | | 70,000 | | | | | |
| Ropes, Manila | | 8,000 | | | | | |
| Belts, sol. woven, cot'n | | 7,300 | | | | | |
| *Belts, solid* woven flax | | 9,900 | | | | | |

**Reinforced Concrete—Safe Working Stresses**

| | |
|---|---|
| Elastic Modulus | 2,000,000 if ult. compression is up to 2,200.<br>2,500,000 if ult. compression is over 2,200.<br>3,000,000 if ult. compression is over 2,900. |
| Compression | 22.5% of ult. compression on piers or columns of lengths not exceeding 12 dia. |
| Bearing | 32.5% of ult. compression on surfaces of at least twice the loaded area. |
| Shearing | 2.0% of ult. compression, horizontal bars.<br>3.0% for reinforcement with bent-up bars.<br>6.0% for thoroughly reinforced webs. |
| Bond | 4% of ult. compression for plain bars.<br>2% for drawn wire. |

*For ultimate* and working stresses of Structural Timber, see page 272.

# United States Standard Gauge

## For Sheet and Plate Iron and Steel

| Gauge Number | Thickness in Fractions of an Inch | Thickness in Decimals of an Inch | Approximate Thickness in Millimeters | Weight per Square Foot, in Pounds, Iron | Weight per Square Foot, in Pounds, Steel | Weight per Square Meter in Kilograms, Steel |
|---|---|---|---|---|---|---|
| 0000000 | 1/2 | .5 | 12.70 | 20. | 20.4 | 99.601 |
| 000000 | 15/32 | .46875 | 11.91 | 18.75 | 19.125 | 93.376 |
| 00000 | 7/16 | .4375 | 11.11 | 17.50 | 17.85 | 87.151 |
| 0000 | 13/32 | .40625 | 10.32 | 16.25 | 16.575 | 80.926 |
| 000 | 3/8 | .375 | 9.53 | 15. | 15.3 | 74.701 |
| 00 | 11/32 | .34375 | 8.73 | 13.75 | 14.025 | 68.476 |
| 0 | 5/16 | .3125 | 7.94 | 12.50 | 12.75 | 62.251 |
| 1 | 9/32 | .28125 | 7.14 | 11.25 | 11.475 | 56.026 |
| 2 | 17/64 | .265625 | 6.75 | 10.625 | 10.8375 | 52.913 |
| 3 | 1/4 | .25 | 6.35 | 10. | 10.2 | 49.800 |
| 4 | 15/64 | .234375 | 5.95 | 9.375 | 9.5625 | 46.688 |
| 5 | 7/32 | .21875 | 5.56 | 8.75 | 8.925 | 43.575 |
| 6 | 13/64 | .203125 | 5.16 | 8.125 | 8.2875 | 40.463 |
| 7 | 3/16 | .1875 | 4.76 | 7.5 | 7.65 | 37.350 |
| 8 | 11/64 | .171875 | 4.37 | 6.875 | 7.0125 | 34.238 |
| 9 | 5/32 | .15625 | 3.97 | 6.25 | 6.375 | 31.125 |
| 10 | 9/64 | .140625 | 3.57 | 5.625 | 5.7375 | 28.013 |
| 11 | 1/8 | .125 | 3.18 | 5. | 5.1 | 24.900 |
| 12 | 7/64 | .109375 | 2.78 | 4.375 | 4.4625 | 21.788 |
| 13 | 3/32 | .09375 | 2.38 | 3.75 | 3.825 | 18.675 |
| 14 | 5/64 | .078125 | 1.98 | 3.125 | 3.1875 | 15.563 |
| 15 | 9/128 | .0703125 | 1.79 | 2.8125 | 2.86875 | 14.006 |
| 16 | 1/16 | .0625 | 1.59 | 2.5 | 2.55 | 12.450 |
| 17 | 9/160 | .05625 | 1.43 | 2.25 | 2.295 | 11.205 |
| 18 | 1/20 | .05 | 1.27 | 2. | 2.04 | 9.960 |
| 19 | 7/160 | .04375 | 1.11 | 1.75 | 1.785 | 8.715 |
| 20 | 3/80 | .0375 | 0.953 | 1.50 | 1.53 | 7.470 |
| 21 | 11/320 | .034375 | 0.873 | 1.375 | 1.4025 | 6.848 |
| 22 | 1/32 | .03125 | 0.794 | 1.25 | 1.275 | 6.225 |
| 23 | 9/320 | .028125 | 0.714 | 1.125 | 1.1475 | 5.603 |
| 24 | 1/40 | .025 | 0.635 | 1. | 1.02 | 4.980 |
| 25 | 7/320 | .021875 | 0.556 | .875 | .8925 | 4.358 |
| 26 | 3/160 | .01875 | 0.476 | .75 | .765 | 3.735 |
| 27 | 11/640 | .0171875 | 0.437 | .6875 | .70125 | 3.424 |
| 28 | 1/64 | .015625 | 0.397 | .625 | .6375 | 3.113 |
| 29 | 9/640 | .0140625 | 0.357 | .5625 | .57375 | 2.801 |
| 30 | 1/80 | .0125 | 0.318 | .5 | .51 | 2.490 |
| 31 | 7/640 | .0109375 | 0.278 | .4375 | .44625 | 2.179 |
| 32 | 13/1280 | .01015625 | 0.258 | .40625 | .414375 | 2.023 |
| 33 | 3/320 | .009375 | 0.238 | .375 | .3825 | 1.868 |
| 34 | 11/1280 | .00859375 | 0.218 | .34375 | .350625 | 1.712 |
| 35 | 5/640 | .0078125 | 0.198 | .3125 | .31875 | 1.556 |
| 36 | 9/1280 | .00703125 | 0.179 | .28125 | .286875 | 1.401 |
| 37 | 17/2560 | .006640625 | 0.169 | .265625 | .2709375 | 1.323 |
| 38 | 1/160 | .00625 | 0.159 | .25 | .255 | 1.245 |

The United States Standard Gauge was legalized by Act of Congress March 3, 1893, as a standard gauge for sheet and plate iron and steel.

Since the use of numbers to express thickness or size leads to confusion, decimal parts of an inch should be employed when fractions can not be used conveniently.

# Birmingham Wire Gauge

## Equivalents in Inches

### Corresponding Weights of Flat Rolled Steel

| Gauge Number | Thickness, Inches | Pounds per Square Foot | Thickness, Inches: Fractional | Thickness, Inches: Decimal | Pounds per Square Foot |
|---|---|---|---|---|---|
| .... | .... | ....... | 1/2 | .5 | 20.4 |
| 0000 | .454 | 18.5232 | 15/32 | .46875 | 19.125 |
| 000 | .425 | 17.34 | 7/16 | .4375 | 17.85 |
| .. | .... | ....... | 13/32 | .40625 | 16.575 |
| 00 | .380 | 15.504 | 3/8 | .375 | 15.3 |
| 0 | .340 | 13.872 | 11/32 | .34375 | 14.025 |
| .... | .... | ....... | 5/16 | .3125 | 12.75 |
| 1 | .300 | 12.24 | 19/64 | .296875 | 12.1125 |
| 2 | .284 | 11.5872 | 9/32 | .28125 | 11.475 |
| 3 | .259 | 10.5672 | 17/64 | .265625 | 10.8375 |
| ... | .... | ....... | 1/4 | .25 | 10.2 |
| 4 | .238 | 9.7104 | 15/64 | .234375 | 9.5625 |
| 5 | .220 | 8.976 | 7/32 | .21875 | 8.925 |
| 6 | .203 | 8.2824 | 13/64 | .203125 | 8.2875 |
| 7 | .180 | 7.344 | 3/16 | .1875 | 7.65 |
| 8 | .165 | 6.732 | 11/64 | .171875 | 7.0125 |
| 9 | .148 | 6.0384 | 5/32 | .15625 | 6.375 |
| 10 | .134 | 5.4672 | 9/64 | .140625 | 5.7375 |
| 11 | .120 | 4.896 | 1/8 | .125 | 5.1 |
| 12 | .109 | 4.4472 | 7/64 | .109375 | 4.4625 |
| 13 | .095 | 3.876 | 3/32 | .09375 | 3.825 |
| 14 | .083 | 3.3864 | 5/64 | .078125 | 3.1875 |
| 15 | .072 | 2.9376 | .. | ....... | ........ |
| 16 | .065 | 2.651 | 1/16 | .0625 | 2.55 |
| 17 | .058 | 2.3664 | .. | ........ | ........ |
| 18 | .049 | 1.9992 | 3/64 | .046875 | 1.9125 |
| 19 | .042 | 1.7136 | .. | ........ | ........ |
| 20 | .035 | 1.428 | .. | ........ | ........ |
| 21 | .032 | 1.3056 | 1/32 | .03125 | 1.275 |
| 22 | .028 | 1.1424 | .. | ........ | ........ |
| 23 | .025 | 1.02 | .. | ........ | ........ |
| 24 | .022 | 0.8976 | .. | ........ | ........ |
| 25 | .020 | 0.816 | .. | ........ | ........ |
| 26 | .018 | 0.7344 | .. | ........ | ........ |
| 27 | .016 | 0.6528 | 1/64 | .015625 | 0.6375 |
| 28 | .014 | 0.5712 | .. | ........ | ........ |
| 29 | .013 | 0.5304 | .. | ........ | ........ |
| 30 | .012 | 0.4896 | .. | ........ | ........ |
| 31 | .010 | 0.408 | .. | ........ | ........ |
| 32 | .009 | 0.3672 | .. | ........ | ........ |
| 33 | .008 | 0.3264 | 1/128 | .0078125 | 0.31875 |
| 34 | .007 | 0.2856 | .. | ........ | ........ |
| *35* | .005 | 0.2040 | .. | ........ | ........ |
| *36* | *.004* | 0.1632 | 1/256 | .00390625 | 0.159375 |

# Comparison of Gauges

## In Decimal Parts of an Inch

| Gauge Number | J & L Gauge | Birmingham Wire(B.W.G.) also known as Stubs Iron Wire | American Wire or Browne & Sharpe | British Imperial Standard Wire (S. W. G.) | Standard Birmingham Sheet and Hoop (B. G.) | United States Standard for Sheet and Plate Iron and Steel |
|---|---|---|---|---|---|---|
| 0000000 | .4900 | ............ | ............ | .500 | ............ | .500 |
| 000000 | .4615 | ............ | .580000 | .464 | ............ | .46875 |
| 00000 | .4305 | .500 | .516500 | .432 | ............ | .4375 |
| 0000 | .3938 | .454 | .460000 | .400 | ............ | .40625 |
| 000 | .3625 | .425 | .409642 | .372 | .5000 | .375 |
| 00 | .3310 | .380 | .364796 | .348 | .4452 | .34375 |
| 0 | .3065 | .340 | .324861 | .324 | .3964 | .3125 |
| 1 | .2830 | .300 | .289297 | .300 | .3532 | .28125 |
| 2 | .2625 | .284 | .257627 | .276 | .3147 | .265625 |
| 3 | .2437 | .259 | .229423 | .252 | .2804 | .25 |
| 4 | .2253 | .238 | .204307 | .232 | .2500 | .234375 |
| 5 | .2070 | .220 | .181940 | .212 | .2225 | .21875 |
| 6 | .1920 | .203 | .162023 | .192 | .1981 | .203125 |
| 7 | .1770 | .180 | .144285 | .176 | .1764 | .1875 |
| 8 | .1620 | .165 | .128490 | .160 | .1570 | .171875 |
| 9 | .1483 | .148 | .114423 | .144 | .1398 | .15625 |
| 10 | .1350 | .134 | .101897 | .128 | .1250 | .140625 |
| 11 | .1205 | .120 | .090742 | .116 | .1113 | .125 |
| 12 | .1055 | .109 | .080808 | .104 | .0991 | .109375 |
| 13 | .0915 | .095 | .071962 | .092 | .0882 | .09375 |
| 14 | .0800 | .083 | .064084 | .080 | .0785 | .078125 |
| 15 | .0720 | .072 | .057068 | .072 | .0699 | .0703125 |
| 16 | .0625 | .065 | .050821 | .064 | .0625 | .0625 |
| 17 | .0540 | .058 | .045257 | .056 | .0556 | .05625 |
| 18 | .0475 | .049 | .040303 | .048 | .0495 | .05 |
| 19 | .0410 | .042 | .035890 | .040 | .0440 | .04375 |
| 20 | .0348 | .035 | .031961 | .036 | .0392 | .0375 |
| 21 | .03175 | .032 | .028462 | .032 | .0349 | .034375 |
| 22 | .0286 | .028 | .025346 | .028 | .03125 | .03125 |
| 23 | .0258 | .025 | .022572 | .024 | .02782 | .028125 |
| 24 | .0230 | .022 | .020101 | .022 | .02476 | .025 |
| 25 | .0204 | .020 | .017900 | .020 | .02204 | .021875 |
| 26 | .0181 | .018 | .015941 | .018 | .01961 | .01875 |
| 27 | .0173 | .016 | .014195 | .0164 | .01745 | .0171875 |
| 28 | .0162 | .014 | .012641 | .0148 | .015625 | .015625 |
| 29 | .0150 | .013 | .011257 | .0136 | .0139 | .0140625 |
| 30 | .0140 | .012 | .010025 | .0124 | .0123 | .0125 |
| 31 | .0132 | .010 | .008928 | .0116 | .0110 | .0109375 |
| 32 | .0128 | .009 | .007950 | .0108 | .0098 | .01015625 |
| 33 | .0118 | .008 | .007080 | .0100 | .0087 | .009375 |
| 34 | .0104 | .007 | .006305 | .0092 | .0077 | .00859375 |
| 35 | .0095 | .005 | .005615 | .0084 | .0069 | .0078125 |
| 36 | .0090 | .004 | .005000 | .0076 | .0061 | .00703125 |
| 37 | .0085 | ............ | .004453 | .0068 | .0054 | .006640625 |
| 38 | .0080 | ............ | .003965 | .0060 | .0048 | .00625 |
| 39 | .0075 | ............ | .003531 | .0052 | ............ | ............ |
| 40 | .0070 | ............ | .003144 | .0048 | ............ | ............ |

Birmingham Wire Gauge is used for No. 8, No. 9 and No. 10 sheared plates also bands and hoops.

United States Standard Gauge is used for No. 11 sheared plates also for Black Plates (Tin mill sizes). Tin Plate is rolled to weight per base box.

J & L Gauge, which corresponds to Washburn & Moen Gauge, is used for all common wire products, unless otherwise specified.

Since the use of numbers to express thickness or size leads to confusion, deci[illegible] parts of an inch should be employed when fractions can not be used conven[illegible]

# Comparison of Inches and Fractions

## With Decimals of a Foot

| Inch | 0" | 1" | 2" | 3" | 4" | 5" | 6" | 7" | 8" | 9" | 10" | 11" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .0 | .0833 | .1667 | .2500 | .3333 | .4167 | .5000 | .5833 | .6667 | .7500 | .8333 | .9167 |
| 1/64 | .0013 | .0846 | .1680 | .2513 | .3346 | .4180 | .5013 | .5846 | .6680 | .7513 | .8346 | .9180 |
| 1/32 | .0026 | .0859 | .1693 | .2526 | .3359 | .4193 | .5026 | .5859 | .6693 | .7526 | .8359 | .9193 |
| 3/64 | .0039 | .0872 | .1706 | .2539 | .3372 | .4206 | .5039 | .5872 | .6706 | .7539 | .8372 | .9206 |
| 1/16 | .0052 | .0885 | .1719 | .2552 | .3385 | .4219 | .5052 | .5885 | .6719 | .7552 | .8385 | .9219 |
| 5/64 | .0065 | .0898 | .1732 | .2565 | .3398 | .4232 | .5065 | .5898 | .6732 | .7565 | .8398 | .9232 |
| 3/32 | .0078 | .0911 | .1745 | .2578 | .3411 | .4245 | .5078 | .5911 | .6745 | .7578 | .8411 | .9245 |
| 7/64 | .0091 | .0924 | .1758 | .2591 | .3424 | .4258 | .5091 | .5924 | .6758 | .7591 | .8424 | .9258 |
| 1/8 | .0104 | .0937 | .1771 | .2604 | .3437 | .4271 | .5104 | .5937 | .6771 | .7604 | .8437 | .9271 |
| 9/64 | .0117 | .0951 | .1784 | .2617 | .3451 | .4284 | .5117 | .5951 | .6784 | .7617 | .8451 | .9284 |
| 5/32 | .0130 | .0964 | .1797 | .2630 | .3464 | .4297 | .5130 | .5964 | .6797 | .7630 | .8464 | .9297 |
| 11/64 | .0143 | .0977 | .1810 | .2643 | .3477 | .4310 | .5143 | .5977 | .6810 | .7643 | .8477 | .9310 |
| 3/16 | .0156 | .0990 | .1823 | .2656 | .3490 | .4323 | .5156 | .5990 | .6823 | .7656 | .8490 | .9323 |
| 13/64 | .0169 | .1003 | .1836 | .2669 | .3503 | .4336 | .5169 | .6003 | .6836 | .7669 | .8503 | .9336 |
| 7/32 | .0182 | .1016 | .1849 | .2682 | .3516 | .4349 | .5182 | .6016 | .6849 | .7682 | .8516 | .9349 |
| 15/64 | .0195 | .1029 | .1862 | .2695 | .3529 | .4362 | .5195 | .6029 | .6862 | .7695 | .8529 | .9362 |
| 1/4 | .0208 | .1042 | .1875 | .2708 | .3542 | .4375 | .5208 | .6042 | .6875 | .7708 | .8542 | .9375 |
| 17/64 | .0221 | .1055 | .1888 | .2721 | .3555 | .4388 | .5221 | .6055 | .6888 | .7721 | .8555 | .9388 |
| 9/32 | .0234 | .1068 | .1901 | .2734 | .3568 | .4401 | .5234 | .6068 | .6901 | .7734 | .8568 | .9401 |
| 19/64 | .0247 | .1081 | .1914 | .2747 | .3581 | .4414 | .5247 | .6081 | .6914 | .7747 | .8581 | .9414 |
| 5/16 | .0260 | .1094 | .1927 | .2760 | .3594 | .4427 | .5260 | .6094 | .6927 | .7760 | .8594 | .9427 |
| 21/64 | .0273 | .1107 | .1940 | .2773 | .3607 | .4440 | .5273 | .6107 | .6940 | .7773 | .8607 | .9440 |
| 11/32 | .0286 | .1120 | .1953 | .2786 | .3620 | .4453 | .5286 | .6120 | .6953 | .7786 | .8620 | .9453 |
| 23/64 | .0299 | .1133 | .1966 | .2799 | .3633 | .4466 | .5299 | .6133 | .6966 | .7799 | .8633 | .9466 |
| 3/8 | .0312 | .1146 | .1979 | .2812 | .3646 | .4479 | .5312 | .6146 | .6979 | .7812 | .8646 | .9479 |
| 25/64 | .0326 | .1159 | .1992 | .2826 | .3659 | .4492 | .5326 | .6159 | .6992 | .7826 | .8659 | .9492 |
| 13/32 | .0339 | .1172 | .2005 | .2839 | .3672 | .4505 | .5339 | .6172 | .7005 | .7839 | .8672 | .9505 |
| 27/64 | .0352 | .1185 | .2018 | .2852 | .3685 | .4518 | .5352 | .6185 | .7018 | .7852 | .8685 | .9518 |
| 7/16 | .0365 | .1198 | .2031 | .2865 | .3698 | .4531 | .5365 | .6198 | .7031 | .7865 | .8698 | .9531 |
| 29/64 | .0378 | .1211 | .2044 | .2878 | .3711 | .4544 | .5378 | .6211 | .7044 | .7878 | .8711 | .9544 |
| 15/32 | .0391 | .1224 | .2057 | .2891 | .3724 | .4557 | .5391 | .6224 | .7057 | .7891 | .8724 | .9557 |
| 31/64 | .0404 | .1237 | .2070 | .2904 | .3737 | .4570 | .5404 | .6237 | .7070 | .7904 | .8737 | .9570 |
| 1/2 | .0517 | .1250 | .2083 | .2917 | .3750 | .4583 | .5417 | .6250 | .7083 | .7917 | .8750 | .9583 |

Continued on next page.

# Comparison of Inches and Fractions

## With Decimals of a Foot

### Continued

| Inch | 0" | 1" | 2" | 3" | 4" | 5" | 6" | 7" | 8" | 9" | 10" | 11" |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33/64 | .0430 | .1263 | .2096 | .2930 | .3763 | .4596 | .5430 | .6263 | .7096 | .7930 | .8763 | .9596 |
| 17/32 | .0443 | .1276 | .2109 | .2943 | .3776 | .4609 | .5443 | .6276 | .7109 | .7943 | .8776 | .9609 |
| 35/64 | .0456 | .1289 | .2122 | .2956 | .3789 | .4622 | .5456 | .6289 | .7122 | .7956 | .8789 | .9622 |
| 9/16 | .0469 | .1302 | .2135 | .2969 | .3802 | .4635 | .5469 | .6302 | .7135 | .7969 | .8802 | .9635 |
| 37/64 | .0482 | .1315 | .2148 | .2982 | .3815 | .4648 | .5482 | .6315 | .7148 | .7982 | .8815 | .9648 |
| 19/32 | .0495 | .1328 | .2161 | .2995 | .3828 | .4661 | .5495 | .6328 | .7161 | .7995 | .8828 | .9661 |
| 39/64 | .0508 | .1341 | .2174 | .3008 | .3841 | .4674 | .5508 | .6341 | .7174 | .8008 | .8841 | .9674 |
| 5/8 | .0521 | .1354 | .2188 | .3021 | .3854 | .4688 | .5521 | .6354 | .7188 | .8021 | .8854 | .9688 |
| 41/64 | .0534 | .1367 | .2201 | .3034 | .3867 | .4701 | .5534 | .6367 | .7201 | .8034 | .8867 | .9701 |
| 21/32 | .0547 | .1380 | .2214 | .3047 | .3880 | .4714 | .5547 | .6380 | .7214 | .8047 | .8880 | .9714 |
| 43/64 | .0560 | .1393 | .2227 | .3060 | .3893 | .4727 | .5560 | .6393 | .7227 | .8060 | .8893 | .9727 |
| 11/16 | .0573 | .1406 | .2240 | .3073 | .3906 | .4740 | .5573 | .6406 | .7240 | .8073 | .8906 | .9740 |
| 45/64 | .0586 | .1419 | .2253 | .3086 | .3919 | .4753 | .5586 | .6419 | .7253 | .8086 | .8919 | .9753 |
| 23/32 | .0599 | .1432 | .2266 | .3099 | .3932 | .4766 | .5599 | .6432 | .7266 | .8099 | .8932 | .9766 |
| 47/64 | .0612 | .1445 | .2279 | .3112 | .3955 | .4779 | .5612 | .6445 | .7279 | .8112 | .8945 | .9779 |
| 3/4 | .0625 | .1458 | .2292 | .3125 | .3958 | .4792 | .5625 | .6458 | .7292 | .8125 | .8958 | .9792 |
| 49/64 | .0638 | .1471 | .2305 | .3138 | .3971 | .4805 | .5638 | .6471 | .7305 | .8138 | .8971 | .9805 |
| 25/32 | .0651 | .1484 | .2318 | .3151 | .3984 | .4818 | .5651 | .6484 | .7318 | .8151 | .8984 | .9818 |
| 51/64 | .0664 | .1497 | .2331 | .3164 | .3997 | .4831 | .5664 | .6497 | .7331 | .8164 | .8997 | .9831 |
| 13/16 | .0677 | .1510 | .2344 | .3177 | .4010 | .4844 | .5677 | .6510 | .7344 | .8177 | .9010 | .9844 |
| 53/64 | .0690 | .1523 | .2357 | .3190 | .4023 | .4857 | .5690 | .6523 | .7357 | .8190 | .9023 | .9857 |
| 27/32 | .0703 | .1536 | .2370 | .3203 | .4036 | .4870 | .5703 | .6536 | .7370 | .8203 | .9036 | .9870 |
| 55/64 | .0716 | .1549 | .2383 | .3216 | .4049 | .4883 | .5716 | .6549 | .7383 | .8216 | .9049 | .9883 |
| 7/8 | .0729 | .1562 | .2396 | .3229 | .4062 | .4896 | .5729 | .6562 | .7396 | .8229 | .9062 | .9896 |
| 57/64 | .0742 | .1576 | .2409 | .3242 | .4076 | .4909 | .5742 | .6576 | .7409 | .8242 | .9076 | .9909 |
| 29/32 | .0755 | .1589 | .2422 | .3255 | .4089 | .4922 | .5755 | .6589 | .7422 | .8255 | .9089 | .9922 |
| 59/64 | .0768 | .1602 | .2435 | .3268 | .4102 | .4935 | .5768 | .6602 | .7435 | .8268 | .9102 | .9935 |
| 15/16 | .0781 | .1615 | .2448 | .3281 | .4115 | .4948 | .5781 | .6615 | .7448 | .8281 | .9115 | .9948 |
| 61/64 | .0794 | .1628 | .2461 | .3294 | .4128 | .4961 | .5794 | .6628 | .7461 | .8294 | .9128 | .9961 |
| 31/32 | .0807 | .1641 | .2474 | .3307 | .4141 | .4974 | .5807 | .6641 | .7474 | .8307 | .9141 | .9974 |
| 63/64 | .0820 | .1654 | .2487 | .3320 | .4154 | .4987 | .5820 | .6654 | .7487 | .8320 | .9154 | .9987 |
| 1 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 1.0000 |

# Comparison of Fractions

## With Decimals of an Inch

| Fractions | | | | Decimals | Fractions | | | | Decimals |
|---|---|---|---|---|---|---|---|---|---|
| 64ths | 32nds | 16ths | 8ths | | 64ths | 32nds | 16ths | 8ths | |
| 1/64 | | | | .015625 | 33/64 | | | | .515625 |
| | 1/32 | | | .03125 | | 17/32 | | | .53125 |
| 3/64 | | | | .046875 | 35/64 | | | | .546875 |
| | | 1/16 | | .0625 | | | 9/16 | | .5625 |
| 5/64 | | | | .078125 | 37/64 | | | | .578125 |
| | 3/32 | | | .09375 | | 19/32 | | | .59375 |
| 7/64 | | | | .109375 | 39/64 | | | | .609375 |
| | | | ⅛ | .125 | | | | ⅝ | .625 |
| 9/64 | | | | .140625 | 41/64 | | | | .640625 |
| | 5/32 | | | .15625 | | 21/32 | | | .65625 |
| 11/64 | | | | .171875 | 43/64 | | | | .671875 |
| | | 3/16 | | .1875 | | | 11/16 | | .6875 |
| 13/64 | | | | .203125 | 45/64 | | | | .703125 |
| | 7/32 | | | .21875 | | 23/32 | | | .71875 |
| 15/64 | | | | .234375 | 47/64 | | | | .734375 |
| | | | ¼ | .25 | | | | ¾ | .75 |
| 17/64 | | | | .265625 | 49/64 | | | | .765625 |
| | 9/32 | | | .28125 | | 25/32 | | | .78125 |
| 19/64 | | | | .296875 | 51/64 | | | | .796875 |
| | | 5/16 | | .3125 | | | 13/16 | | .8125 |
| 21/64 | | | | .328125 | 53/64 | | | | .828125 |
| | 11/32 | | | .34375 | | 27/32 | | | .84375 |
| 23/64 | | | | .359375 | 55/64 | | | | .859375 |
| | | | ⅜ | .375 | | | | ⅞ | .875 |
| 25/64 | | | | .390625 | 57/64 | | | | .890625 |
| | 13/32 | | | .40625 | | 29/32 | | | .90625 |
| 27/64 | | | | .421875 | 59/64 | | | | .921875 |
| | | 7/16 | | .4375 | | | 15/16 | | .9375 |
| 29/64 | | | | .453125 | 61/64 | | | | .953125 |
| | 15/32 | | | .46875 | | 31/32 | | | .96875 |
| 31/64 | | | | .484375 | 63/64 | | | | .984375 |
| | | | ½ | .5 | | | | 1 | 1.00 |

# Metric Conversion Table

## Inches² to Centimeters² —1 in.² = 6.451625 cm².

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 6.452 | 12.903 | 19.355 | 25.807 | 32.258 | 38.710 | 45.161 | 51.613 | 58.065 |
| 10 | 64.516 | 70.968 | 77.420 | 83.871 | 90.323 | 96.774 | 103.226 | 109.678 | 116.129 | 122.581 |
| 20 | 129.003 | 135.484 | 141.936 | 148.387 | 154.839 | 161.291 | 167.742 | 174.194 | 180.646 | 187.097 |
| 30 | 193.549 | 200.000 | 206.452 | 212.904 | 219.355 | 225.807 | 232.259 | 238.710 | 245.162 | 251.613 |
| 40 | 258.065 | 264.517 | 270.968 | 277.420 | 283.872 | 290.323 | 296.775 | 303.226 | 309.678 | 316.130 |
| 50 | 322.581 | 329.033 | 335.485 | 341.936 | 348.388 | 354.839 | 361.291 | 367.743 | 374.194 | 380.646 |
| 60 | 387.098 | 393.549 | 400.001 | 406.452 | 412.904 | 419.356 | 425.807 | 432.259 | 438.711 | 445.162 |
| 70 | 451.614 | 458.065 | 464.517 | 470.969 | 477.420 | 483.872 | 490.324 | 496.775 | 503.227 | 509.678 |
| 80 | 516.130 | 522.582 | 529.033 | 535.485 | 541.937 | 548.388 | 554.840 | 561.291 | 567.743 | 574.195 |
| 90 | 580.646 | 587.098 | 593.550 | 600.001 | 606.453 | 612.904 | 619.356 | 625.808 | 632.259 | 638.711 |

## Centimeters² to Inches² — 1 cm² = 0.15499969 in.².

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.1550 | 0.3100 | 0.4650 | 0.6200 | 0.7750 | 0.9300 | 1.0850 | 1.2400 | 1.3950 |
| 10 | 1.5500 | 1.7050 | 1.8600 | 2.0150 | 2.1700 | 2.3250 | 2.4800 | 2.6350 | 2.7900 | 2.9450 |
| 20 | 3.1000 | 3.2550 | 3.4100 | 3.5650 | 3.7200 | 3.8750 | 4.0300 | 4.1850 | 4.3400 | 4.4950 |
| 30 | 4.6500 | 4.8050 | 4.9600 | 5.1150 | 5.2700 | 5.4250 | 5.5800 | 5.7350 | 5.8900 | 6.0450 |
| 40 | 6.2000 | 6.3550 | 6.5100 | 6.6650 | 6.8200 | 6.9750 | 7.1300 | 7.2850 | 7.4400 | 7.5950 |
| 50 | 7.7500 | 7.9050 | 8.0600 | 8.2150 | 8.3700 | 8.5250 | 8.6800 | 8.8350 | 8.9900 | 9.1450 |
| 60 | 9.3000 | 9.4550 | 9.6100 | 9.7650 | 9.9200 | 10.0750 | 10.2300 | 10.3850 | 10.5400 | 10.6950 |
| 70 | 10.8500 | 11.0050 | 11.1600 | 11.3150 | 11.4700 | 11.6250 | 11.7800 | 11.9350 | 12.0900 | 12.2450 |
| 80 | 12.4000 | 12.5550 | 12.7100 | 12.8650 | 13.0200 | 13.1750 | 13.3300 | 13.4850 | 13.6400 | 13.7950 |
| 90 | 13.9500 | 14.1050 | 14.2600 | 14.4150 | 14.5700 | 14.7250 | 14.8800 | 15.0350 | 15.1900 | 15.3450 |

## Inches³ to Centimeters³ — 1 in.³ = 16.38716 cm³.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 16.39 | 32.77 | 49.16 | 65.55 | 81.94 | 98.32 | 114.71 | 131.10 | 147.48 |
| 10 | 163.87 | 180.26 | 196.65 | 213.03 | 229.42 | 245.81 | 262.19 | 278.58 | 294.97 | 311.36 |
| 20 | 327.74 | 344.13 | 360.52 | 376.90 | 393.29 | 409.68 | 426.07 | 442.45 | 458.84 | 475.23 |
| 30 | 491.61 | 508.00 | 524.39 | 540.78 | 557.16 | 573.55 | 589.94 | 606.32 | 622.71 | 639.10 |
| 40 | 655.49 | 671.87 | 688.26 | 704.65 | 721.04 | 737.42 | 753.81 | 770.20 | 786.58 | 802.97 |
| 50 | 819.36 | 835.75 | 852.13 | 868.52 | 884.91 | 901.29 | 917.68 | 934.07 | 950.46 | 966.84 |
| 60 | 983.23 | 999.62 | 1016.00 | 1032.39 | 1048.78 | 1065.17 | 1081.55 | 1097.94 | 1114.33 | 1130.71 |
| 70 | 1147.10 | 1163.49 | 1179.88 | 1196.26 | 1212.65 | 1229.04 | 1245.42 | 1261.81 | 1278.20 | 1294.59 |
| 80 | 1310.97 | 1327.36 | 1343.75 | 1360.13 | 1376.52 | 1392.91 | 1409.30 | 1425.68 | 1442.07 | 1458.46 |
| 90 | 1474.84 | 1491.23 | 1507.62 | 1524.01 | 1540.39 | 1556.78 | 1573.17 | 1589.55 | 1605.94 | 1622.33 |

## Centimeters³ to Inches³ — 1 cm³ = 0.0610234 in.³.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.06102 | 0.12205 | 0.18307 | 0.24409 | 0.30512 | 0.36614 | 0.42716 | 0.48819 | 0.54921 |
| 10 | 0.61023 | 0.67126 | 0.73288 | 0.79330 | 0.85433 | 0.91535 | 0.97637 | 1.03740 | 1.09842 | 1.15944 |
| 20 | 1.22047 | 1.28149 | 1.34251 | 1.40354 | 1.46456 | 1.52559 | 1.58661 | 1.64763 | 1.70866 | 1.76968 |
| 30 | 1.83070 | 1.89173 | 1.95275 | 2.01377 | 2.07480 | 2.13582 | 2.19684 | 2.25787 | 2.31889 | 2.37991 |
| 40 | 2.44094 | 2.50196 | 2.56298 | 2.62401 | 2.68503 | 2.74605 | 2.80708 | 2.86810 | 2.92912 | 2.99015 |
| 50 | 3.05117 | 3.11219 | 3.17322 | 3.23424 | 3.29526 | 3.35629 | 3.41731 | 3.47833 | 3.53936 | 3.60038 |
| 60 | 3.66140 | 3.72243 | 3.78345 | 3.84447 | 3.90550 | 3.96652 | 4.02754 | 4.08857 | 4.14959 | 4.21061 |
| 70 | 4.27164 | 4.33266 | 4.39368 | 4.45471 | 4.51573 | 4.57675 | 4.63778 | 4.69880 | 4.75983 | 4.82085 |
| 80 | 4.88187 | 4.94290 | 5.00392 | 5.06494 | 5.12597 | 5.18699 | 5.24801 | 5.30904 | 5.37006 | 5.43108 |
| 90 | 5.49211 | 5.55313 | 5.61415 | 5.67518 | 5.73620 | 5.79722 | 5.85825 | 5.91927 | 5.98029 | 6.04[illegible] |

# Metric Conversion Table

**Continued**

## Pounds per Sq. Inch to Kg. per Sq. Cm.—1 lb./in² = 0.0703067 kg/cm².

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.07031 | 0.14061 | 0.21092 | 0.28123 | 0.35153 | 0.42184 | 0.49215 | 0.56245 | 0.63276 |
| 10 | 0.70307 | 0.77337 | 0.84368 | 0.91399 | 0.98429 | 1.05460 | 1.12491 | 1.19521 | 1.26552 | 1.33583 |
| 20 | 1.40613 | 1.47644 | 1.54675 | 1.61705 | 1.68736 | 1.75767 | 1.82797 | 1.89828 | 1.96859 | 2.03889 |
| 30 | 2.10920 | 2.17951 | 2.24981 | 2.32012 | 2.39043 | 2.46073 | 2.53104 | 2.60135 | 2.67165 | 2.74196 |
| 40 | 2.81227 | 2.88257 | 2.95288 | 3.02319 | 3.09349 | 3.16380 | 3.23411 | 3.30441 | 3.37472 | 3.44503 |
| 50 | 3.51534 | 3.58564 | 3.65595 | 3.72626 | 3.79656 | 3.86687 | 3.93718 | 4.00748 | 4.07779 | 4.14810 |
| 60 | 4.21840 | 4.28871 | 4.35902 | 4.42932 | 4.49963 | 4.56994 | 4.64024 | 4.71055 | 4.78086 | 4.85116 |
| 70 | 4.92147 | 4.99178 | 5.06208 | 5.13239 | 5.20270 | 5.27300 | 5.34331 | 5.41362 | 5.48392 | 5.55423 |
| 80 | 5.62454 | 5.69484 | 5.76515 | 5.83546 | 5.90576 | 5.97607 | 6.04638 | 6.11668 | 6.18699 | 6.25730 |
| 90 | 6.32760 | 6.39791 | 6.46822 | 6.53852 | 6.60883 | 6.67914 | 6.74944 | 6.81975 | 6.89006 | 6.96036 |

## Kg. per Sq. Cm. to Pounds per Sq. Inch—1 kg/cm² = 14.2234 lbs./in.².

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 14.22 | 28.45 | 42.67 | 56.89 | 71.12 | 85.34 | 99.56 | 113.79 | 128.01 |
| 10 | 142.23 | 156.46 | 170.68 | 184.90 | 199.13 | 213.35 | 227.57 | 241.80 | 256.02 | 270.24 |
| 20 | 284.47 | 298.69 | 312.91 | 327.14 | 341.36 | 355.59 | 369.81 | 384.03 | 398.26 | 412.48 |
| 30 | 426.70 | 440.93 | 455.15 | 469.37 | 483.60 | 497.82 | 512.04 | 526.27 | 540.49 | 554.71 |
| 40 | 568.94 | 583.16 | 597.38 | 611.61 | 625.83 | 640.05 | 654.28 | 668.50 | 682.72 | 696.95 |
| 50 | 711.17 | 725.39 | 739.62 | 753.84 | 768.06 | 782.29 | 796.51 | 810.73 | 824.96 | 839.18 |
| 60 | 853.40 | 867.63 | 881.85 | 896.07 | 910.30 | 924.52 | 938.74 | 952.97 | 967.19 | 981.41 |
| 70 | 995.64 | 1009.86 | 1024.08 | 1038.31 | 1052.53 | 1066.76 | 1080.98 | 1095.20 | 1109.43 | 1123.65 |
| 80 | 1137.87 | 1152.10 | 1166.32 | 1180.54 | 1194.77 | 1208.99 | 1223.21 | 1237.44 | 1251.66 | 1265.88 |
| 90 | 1280.11 | 1294.33 | 1308.55 | 1322.78 | 1337.00 | 1351.22 | 1365.45 | 1379.67 | 1393.89 | 1408.12 |

## Kilograms per Meter to Pounds per Foot—1 kg/m = 0.67197 lb./ft.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.6720 | 1.3439 | 2.0159 | 2.6879 | 3.3599 | 4.0318 | 4.7038 | 5.3758 | 6.0477 |
| 10 | 6.7197 | 7.3917 | 8.0636 | 8.7356 | 9.4076 | 10.0796 | 10.7515 | 11.4235 | 12.0955 | 12.7674 |
| 20 | 13.4394 | 14.1114 | 14.7833 | 15.4553 | 16.1273 | 16.7993 | 17.4712 | 18.1432 | 18.8152 | 19.4871 |
| 30 | 20.1591 | 20.8311 | 21.5030 | 22.1750 | 22.8470 | 23.5190 | 24.1909 | 24.8629 | 25.5349 | 26.2068 |
| 40 | 26.8788 | 27.5508 | 28.2227 | 28.8947 | 29.5667 | 30.2387 | 30.9106 | 31.5826 | 32.2546 | 32.9265 |
| 50 | 33.5985 | 34.2705 | 34.9424 | 35.6144 | 36.2864 | 36.9584 | 37.6303 | 38.3022 | 38.9743 | 39.6462 |
| 60 | 40.3182 | 40.9902 | 41.6621 | 42.3341 | 43.0061 | 43.6781 | 44.3500 | 45.0220 | 45.6940 | 46.3659 |
| 70 | 47.0379 | 47.7099 | 48.3818 | 49.0538 | 49.7258 | 50.3978 | 51.0697 | 51.7417 | 52.4137 | 53.0856 |
| 80 | 53.7576 | 54.4296 | 55.1015 | 55.7735 | 56.4455 | 57.1175 | 57.7894 | 58.4614 | 59.1334 | 59.8053 |
| 90 | 60.4773 | 61.1493 | 61.8212 | 62.4932 | 63.1652 | 63.8372 | 64.5091 | 65.1811 | 65.8531 | 66.5250 |

## Pounds per Foot to Kilograms per Meter—1 lb./ft. = 1.48816 kg/m.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 1.488 | 2.976 | 4.464 | 5.953 | 7.441 | 8.929 | 10.417 | 11.905 | 13.393 |
| 10 | 14.882 | 16.370 | 17.858 | 19.346 | 20.834 | 22.322 | 23.811 | 25.299 | 26.787 | 28.275 |
| 20 | 29.763 | 31.251 | 32.740 | 34.228 | 35.716 | 37.204 | 38.692 | 40.180 | 41.669 | 43.157 |
| 30 | 44.645 | 46.133 | 47.621 | 49.109 | 50.597 | 52.086 | 53.574 | 55.062 | 56.550 | 58.038 |
| 40 | 59.526 | 61.015 | 62.503 | 63.991 | 65.479 | 66.967 | 68.455 | 69.944 | 71.432 | 72.920 |
| 50 | 74.408 | 75.896 | 77.384 | 78.873 | 80.361 | 81.849 | 83.337 | 84.825 | 86.313 | 87.802 |
| 60 | 89.290 | 90.778 | 92.266 | 93.754 | 95.242 | 96.730 | 98.219 | 99.707 | 101.195 | 102.683 |
| 70 | 104.171 | 105.659 | 107.148 | 108.636 | 110.124 | 111.612 | 113.100 | 114.588 | 116.077 | 117.565 |
| 80 | *119.053* | 120.541 | 122.029 | 123.517 | 125.006 | 126.494 | 127.982 | 129.470 | 130.958 | 132.446 |
| 90 | *133.934* | *135.423* | 136.911 | 138.399 | 139.887 | 141.375 | 142.863 | 144.352 | 145.840 | 147.328 |

# Metric Conversion Table

**Continued**

## Inches to Centimeters — 1 in. = 2.540005 cm.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 2.540 | 5.080 | 7.620 | 10.160 | 12.700 | 15.240 | 17.780 | 20.320 | 22.860 |
| 10 | 25.400 | 27.940 | 30.480 | 33.020 | 35.560 | 38.100 | 40.640 | 43.180 | 45.720 | 48.260 |
| 20 | 50.800 | 53.340 | 55.880 | 58.420 | 60.960 | 63.500 | 66.040 | 68.580 | 71.120 | 73.660 |
| 30 | 76.200 | 78.740 | 81.280 | 83.820 | 86.360 | 88.900 | 91.440 | 93.980 | 96.520 | 99.060 |
| 40 | 101.600 | 104.140 | 106.680 | 109.220 | 111.760 | 114.300 | 116.840 | 119.380 | 121.920 | 124.460 |
| 50 | 127.000 | 129.540 | 132.080 | 134.620 | 137.160 | 139.700 | 142.240 | 144.780 | 147.320 | 149.860 |
| 60 | 152.400 | 154.940 | 157.480 | 160.020 | 162.560 | 165.100 | 167.640 | 170.180 | 172.720 | 175.260 |
| 70 | 177.800 | 180.340 | 182.880 | 185.420 | 187.960 | 190.500 | 193.040 | 195.580 | 198.120 | 200.660 |
| 80 | 203.200 | 205.740 | 208.280 | 210.820 | 213.360 | 215.900 | 218.440 | 220.980 | 223.520 | 226.060 |
| 90 | 228.600 | 231.140 | 233.680 | 236.220 | 238.760 | 241.300 | 243.840 | 246.380 | 248.920 | 251.460 |

## Centimeters to Inches — 1 cm = 0.3937 in.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.3937 | 0.7874 | 1.1811 | 1.5748 | 1.9685 | 2.3622 | 2.7559 | 3.1496 | 3.5433 |
| 10 | 3.9370 | 4.3307 | 4.7244 | 5.1181 | 5.5118 | 5.9055 | 6.2992 | 6.6929 | 7.0866 | 7.4803 |
| 20 | 7.8740 | 8.2677 | 8.6614 | 9.0551 | 9.4488 | 9.8425 | 10.2362 | 10.6299 | 11.0236 | 11.4173 |
| 30 | 11.8110 | 12.2047 | 12.5984 | 12.9921 | 13.3858 | 13.7795 | 14.1732 | 14.5669 | 14.9606 | 15.3543 |
| 40 | 15.7480 | 16.1417 | 16.5354 | 16.9291 | 17.3228 | 17.7165 | 18.1102 | 18.5039 | 18.8976 | 19.2913 |
| 50 | 19.6850 | 20.0787 | 20.4724 | 20.8661 | 21.2598 | 21.6535 | 22.0472 | 22.4409 | 22.8346 | 23.2283 |
| 60 | 23.6220 | 24.0157 | 24.4094 | 24.8031 | 25.1968 | 25.5905 | 25.9842 | 26.3779 | 26.7716 | 27.1653 |
| 70 | 27.5590 | 27.9527 | 28.3464 | 28.7401 | 29.1338 | 29.5275 | 29.9212 | 30.3149 | 30.7086 | 31.1023 |
| 80 | 31.4960 | 31.8897 | 32.2834 | 32.6771 | 33.0708 | 33.4645 | 33.8582 | 34.2519 | 34.6456 | 35.0393 |
| 90 | 35.4330 | 35.8267 | 36.2204 | 36.6141 | 37.0078 | 37.4015 | 37.7952 | 38.1889 | 38.5826 | 38.9763 |

## Feet to Meters — 1 ft. = 0.3048006 m.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.3048 | 0.6096 | 0.9144 | 1.2192 | 1.5240 | 1.8288 | 2.1336 | 2.4384 | 2.7432 |
| 10 | 3.0480 | 3.3528 | 3.6576 | 3.9624 | 4.2672 | 4.5720 | 4.8768 | 5.1816 | 5.4864 | 5.7912 |
| 20 | 6.0960 | 6.4008 | 6.7056 | 7.0104 | 7.3152 | 7.6200 | 7.9248 | 8.2296 | 8.5344 | 8.8392 |
| 30 | 9.1440 | 9.4488 | 9.7536 | 10.0584 | 10.3632 | 10.6680 | 10.9728 | 11.2776 | 11.5824 | 11.8872 |
| 40 | 12.1920 | 12.4968 | 12.8016 | 13.1064 | 13.4112 | 13.7160 | 14.0208 | 14.3256 | 14.6304 | 14.9352 |
| 50 | 15.2400 | 15.5448 | 15.8496 | 16.1544 | 16.4592 | 16.7640 | 17.0688 | 17.3736 | 17.6784 | 17.9832 |
| 60 | 18.2880 | 18.5928 | 18.8976 | 19.2024 | 19.5072 | 19.8120 | 20.1168 | 20.4216 | 20.7264 | 21.0312 |
| 70 | 21.3360 | 21.6408 | 21.9456 | 22.2504 | 22.5552 | 22.8600 | 23.1648 | 23.4696 | 23.7744 | 24.0792 |
| 80 | 24.3840 | 24.6888 | 24.9936 | 25.2984 | 25.6033 | 25.9081 | 26.2129 | 26.5177 | 26.8225 | 27.1273 |
| 90 | 27.4321 | 27.7369 | 28.0417 | 28.3465 | 28.6513 | 28.9561 | 29.2609 | 29.5657 | 29.8705 | 30.1753 |

## Meters to Feet — 1 m = 3.2808333 ft.

| Tens | Units 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 3.281 | 6.562 | 9.843 | 13.123 | 16.404 | 19.685 | 22.966 | 26.247 | 29.528 |
| 10 | 32.808 | 36.089 | 39.370 | 42.651 | 45.932 | 49.213 | 52.493 | 55.774 | 59.055 | 62.336 |
| 20 | 65.617 | 68.898 | 72.178 | 75.459 | 78.740 | 82.021 | 85.302 | 88.583 | 91.863 | 95.144 |
| 30 | 98.425 | 101.706 | 104.987 | 108.268 | 111.548 | 114.829 | 118.110 | 121.391 | 124.672 | 127.953 |
| 40 | 131.233 | 134.514 | 137.795 | 141.076 | 144.357 | 147.638 | 150.918 | 154.199 | 157.480 | 160.761 |
| 50 | 164.042 | 167.323 | 170.603 | 173.884 | 177.165 | 180.446 | 183.727 | 187.008 | 190.288 | 193.569 |
| 60 | 196.850 | 200.131 | 203.412 | 206.693 | 209.973 | 213.254 | 216.535 | 219.816 | 223.097 | 226.378 |
| 70 | 229.658 | 232.939 | 236.220 | 239.501 | 242.782 | 246.063 | 249.343 | 252.624 | 255.905 | 259.186 |
| 80 | 262.467 | 265.748 | 269.028 | 272.309 | 275.590 | 278.871 | 282.152 | 285.433 | 288.713 | 291.994 |
| 90 | 295.275 | 298.556 | 301.837 | 305.118 | 308.398 | 311.679 | 314.960 | 318.241 | 321.522 | 324.803 |

# Metric Conversion Table
**Continued**

## Inches to Millimeters

39.37 inches, U. S. Standard = 1 meter = 100 centimeters = 1000 millimeters.

| Inches | 0 | 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 1.59 | 3.18 | 4.76 | 6.35 | 7.94 | 9.53 | 11.11 |
| 1 | 25.40 | 26.99 | 28.58 | 30.16 | 31.75 | 33.34 | 34.93 | 36.51 |
| 2 | 50.80 | 52.39 | 53.98 | 55.56 | 57.15 | 58.74 | 60.33 | 61.91 |
| 3 | 76.20 | 77.79 | 79.38 | 80.96 | 82.55 | 84.14 | 85.73 | 87.31 |
| 4 | 101.60 | 103.19 | 104.78 | 106.36 | 107.95 | 109.54 | 111.13 | 112.71 |
| 5 | 127.00 | 128.59 | 130.18 | 131.76 | 133.35 | 134.94 | 136.53 | 138.11 |
| 6 | 152.40 | 153.99 | 155.58 | 157.16 | 158.75 | 160.34 | 161.93 | 163.51 |
| 7 | 177.80 | 179.39 | 180.98 | 182.56 | 184.15 | 185.74 | 187.33 | 188.91 |
| 8 | 203.20 | 204.79 | 206.38 | 207.96 | 209.55 | 211.14 | 212.73 | 214.31 |
| 9 | 228.60 | 230.19 | 231.78 | 233.36 | 234.95 | 236.54 | 238.13 | 239.71 |
| 10 | 254.00 | 255.59 | 257.18 | 258.76 | 260.35 | 261.94 | 263.53 | 265.11 |
| 11 | 279.40 | 280.99 | 282.58 | 284.16 | 285.75 | 287.34 | 288.93 | 290.51 |
| 12 | 304.80 | 306.39 | 307.98 | 309.56 | 311.15 | 312.74 | 314.33 | 315.91 |
| 13 | 330.20 | 331.79 | 333.38 | 334.96 | 336.55 | 338.14 | 339.73 | 341.31 |
| 14 | 355.60 | 357.19 | 358.78 | 360.36 | 361.95 | 363.54 | 365.13 | 366.71 |
| 15 | 381.00 | 382.59 | 384.18 | 385.76 | 387.35 | 388.94 | 390.53 | 392.11 |
| 16 | 406.40 | 407.99 | 409.58 | 411.16 | 412.75 | 414.34 | 415.93 | 417.51 |
| 17 | 431.80 | 433.39 | 434.98 | 436.56 | 438.15 | 439.74 | 441.33 | 442.91 |
| 18 | 457.20 | 458.79 | 460.38 | 461.96 | 463.55 | 465.14 | 466.73 | 468.31 |
| 19 | 482.60 | 484.19 | 485.78 | 487.36 | 488.95 | 490.54 | 492.13 | 493.71 |
| 20 | 508.00 | 509.59 | 511.18 | 512.76 | 514.35 | 515.94 | 517.53 | 519.11 |
| 21 | 533.40 | 534.99 | 536.58 | 538.16 | 539.75 | 541.34 | 542.93 | 544.51 |
| 22 | 558.80 | 560.39 | 561.98 | 563.56 | 565.15 | 566.74 | 568.33 | 569.91 |
| 23 | 584.20 | 585.79 | 587.38 | 588.96 | 590.55 | 592.14 | 593.73 | 595.31 |
| 24 | 609.60 | 611.19 | 612.78 | 614.36 | 615.95 | 617.54 | 619.13 | 620.71 |
| 25 | 635.00 | 636.59 | 638.18 | 639.76 | 641.35 | 642.94 | 644.53 | 646.11 |
| 26 | 660.40 | 661.99 | 663.58 | 665.16 | 666.75 | 668.34 | 669.93 | 671.51 |
| 27 | 685.80 | 687.39 | 688.98 | 690.56 | 692.15 | 693.74 | 695.33 | 696.91 |
| 28 | 711.20 | 712.79 | 714.38 | 715.96 | 717.55 | 719.14 | 720.73 | 722.31 |
| 29 | 736.60 | 738.19 | 739.78 | 741.36 | 742.95 | 744.54 | 746.13 | 747.71 |
| 30 | 762.00 | 763.59 | 765.18 | 766.76 | 768.35 | 769.94 | 771.53 | 773.11 |
| 31 | 787.40 | 788.99 | 790.58 | 792.16 | 793.75 | 795.34 | 796.93 | 798.51 |
| 32 | 812.80 | 814.39 | 815.98 | 817.56 | 819.15 | 820.74 | 822.33 | 823.91 |
| 33 | 838.20 | 839.79 | 841.38 | 842.96 | 844.55 | 846.14 | 847.73 | 849.31 |
| 34 | 863.60 | 865.19 | 866.78 | 868.36 | 869.95 | 871.54 | 873.13 | 874.71 |
| 35 | 889.00 | 890.59 | 892.18 | 893.76 | 895.35 | 896.94 | 898.53 | 900.11 |
| 36 | 914.40 | 915.99 | 917.58 | 919.16 | 920.75 | 922.34 | 923.93 | 925.51 |
| 37 | 939.80 | 941.39 | 942.98 | 944.56 | 946.15 | 947.74 | 949.33 | 950.91 |
| 38 | 965.20 | 966.79 | 968.38 | 969.96 | 971.55 | 973.14 | 974.73 | 976.31 |
| 39 | 990.60 | 992.19 | 993.78 | 995.36 | 996.95 | 998.54 | 1000.13 | 1001.71 |
| 40 | 1016.00 | 1017.59 | 1019.18 | 1020.76 | 1022.35 | 1023.94 | 1025.53 | 1027.11 |
| 41 | 1041.40 | 1042.99 | 1044.58 | 1046.16 | 1047.75 | 1049.34 | 1050.93 | 1052.51 |
| 42 | 1066.80 | 1068.39 | 1069.98 | 1071.56 | 1073.15 | 1074.74 | 1076.33 | 1077.91 |
| 43 | 1092.20 | 1093.79 | 1095.38 | 1096.96 | 1098.55 | 1100.14 | 1101.73 | 1103.31 |
| 44 | 1117.60 | 1119.19 | 1120.78 | 1122.36 | 1123.95 | 1125.54 | 1127.13 | 1128.71 |
| 45 | 1143.00 | 1144.59 | 1146.18 | 1147.76 | 1149.35 | 1150.94 | 1152.53 | 1154.11 |
| 46 | 1168.40 | 1169.99 | 1171.58 | 1173.16 | 1174.75 | 1176.34 | 1177.93 | 1179.51 |
| 47 | 1193.80 | 1195.39 | 1196.98 | 1198.56 | 1200.15 | 1201.74 | 1203.33 | 1204.91 |
| 48 | 1219.20 | 1220.79 | 1222.38 | 1223.96 | 1225.55 | 1227.14 | 1228.73 | 1230.31 |
| 49 | 1244.60 | 1246.19 | 1247.78 | 1249.36 | 1250.95 | 1252.54 | 1254.13 | 1255.71 |
| 50 | 1270.00 | 1271.59 | 1273.18 | 1274.76 | 1276.35 | 1277.94 | 1279.53 | 1281.11 |

*Continued on next page.*

# Metric Conversion Table

**Continued**

## Inches to Millimeters

39.37 inches, U. S. Standard = 1 meter = 100 centimeters = 1000 millimeters.

| Inches | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 |
|---|---|---|---|---|---|---|---|---|
| 0 | 12.70 | 14.29 | 15.88 | 17.46 | 19.05 | 20.64 | 22.23 | 23.81 |
| 1 | 38.10 | 39.69 | 41.28 | 42.86 | 44.45 | 46.04 | 47.63 | 49.21 |
| 2 | 63.50 | 65.09 | 66.68 | 68.26 | 69.85 | 71.44 | 73.03 | 74.61 |
| 3 | 88.90 | 90.49 | 92.08 | 93.66 | 95.25 | 96.84 | 98.43 | 100.01 |
| 4 | 114.30 | 115.89 | 117.48 | 119.06 | 120.65 | 122.24 | 123.83 | 125.41 |
| 5 | 139.70 | 141.29 | 142.88 | 144.46 | 146.05 | 147.64 | 149.23 | 150.81 |
| 6 | 165.10 | 166.69 | 168.28 | 169.86 | 171.45 | 173.04 | 174.63 | 176.21 |
| 7 | 190.50 | 192.09 | 193.68 | 195.26 | 196.85 | 198.44 | 200.03 | 201.61 |
| 8 | 215.90 | 217.49 | 219.08 | 220.66 | 222.25 | 223.84 | 225.43 | 227.01 |
| 9 | 241.30 | 242.89 | 244.48 | 246.06 | 247.65 | 249.24 | 250.83 | 252.41 |
| 10 | 266.70 | 268.29 | 269.88 | 271.46 | 273.05 | 274.64 | 276.23 | 277.81 |
| 11 | 292.10 | 293.69 | 295.28 | 296.86 | 298.45 | 300.04 | 301.63 | 303.21 |
| 12 | 317.50 | 319.09 | 320.68 | 322.26 | 323.85 | 325.44 | 327.03 | 328.61 |
| 13 | 342.90 | 344.49 | 346.08 | 347.66 | 349.25 | 350.84 | 352.43 | 354.01 |
| 14 | 368.30 | 369.89 | 371.48 | 373.06 | 374.65 | 376.24 | 377.83 | 379.41 |
| 15 | 393.70 | 395.29 | 396.88 | 398.46 | 400.05 | 401.64 | 403.23 | 404.81 |
| 16 | 419.10 | 420.69 | 422.28 | 423.86 | 425.45 | 427.04 | 428.63 | 430.21 |
| 17 | 444.50 | 446.09 | 447.68 | 449.26 | 450.85 | 452.44 | 454.03 | 455.61 |
| 18 | 469.90 | 471.49 | 473.08 | 474.66 | 476.25 | 477.84 | 479.43 | 481.01 |
| 19 | 495.30 | 496.89 | 498.48 | 500.06 | 501.65 | 503.24 | 504.83 | 506.41 |
| 20 | 520.70 | 522.29 | 523.88 | 525.46 | 527.05 | 528.64 | 530.23 | 531.81 |
| 21 | 546.10 | 547.69 | 549.28 | 550.86 | 552.45 | 554.04 | 555.63 | 557.21 |
| 22 | 571.50 | 573.09 | 574.68 | 576.26 | 577.85 | 579.44 | 581.03 | 582.61 |
| 23 | 596.90 | 598.49 | 600.08 | 601.66 | 603.25 | 604.84 | 606.43 | 608.01 |
| 24 | 622.30 | 623.89 | 625.48 | 627.06 | 628.65 | 630.24 | 631.83 | 633.41 |
| 25 | 647.70 | 649.29 | 650.88 | 652.46 | 654.05 | 655.64 | 657.23 | 658.81 |
| 26 | 673.10 | 674.69 | 676.28 | 677.86 | 679.45 | 681.04 | 682.63 | 684.21 |
| 27 | 698.50 | 700.09 | 701.68 | 703.26 | 704.85 | 706.44 | 708.03 | 709.61 |
| 28 | 723.90 | 725.49 | 727.08 | 728.66 | 730.25 | 731.84 | 733.43 | 735.01 |
| 29 | 749.30 | 750.89 | 752.48 | 754.06 | 755.65 | 757.24 | 758.83 | 760.41 |
| 30 | 774.70 | 776.29 | 777.88 | 779.46 | 781.05 | 782.64 | 784.23 | 785.81 |
| 31 | 800.10 | 801.69 | 803.28 | 804.86 | 806.45 | 808.04 | 809.63 | 811.21 |
| 32 | 825.50 | 827.09 | 828.68 | 830.26 | 831.85 | 833.44 | 835.03 | 836.61 |
| 33 | 850.90 | 852.49 | 854.08 | 855.66 | 857.25 | 858.84 | 860.43 | 862.01 |
| 34 | 876.30 | 877.89 | 879.48 | 881.06 | 882.65 | 884.24 | 885.83 | 887.41 |
| 35 | 901.70 | 903.29 | 904.88 | 906.46 | 908.05 | 909.64 | 911.23 | 912.81 |
| 36 | 927.10 | 928.69 | 930.28 | 931.86 | 933.45 | 935.04 | 936.63 | 938.21 |
| 37 | 952.50 | 954.09 | 955.68 | 957.26 | 958.85 | 960.44 | 962.03 | 963.61 |
| 38 | 977.90 | 979.49 | 981.08 | 982.66 | 984.25 | 985.84 | 987.43 | 989.01 |
| 39 | 1003.30 | 1004.89 | 1006.48 | 1008.06 | 1009.65 | 1011.24 | 1012.83 | 1014.41 |
| 40 | 1028.70 | 1030.29 | 1031.88 | 1033.46 | 1035.05 | 1036.64 | 1038.23 | 1039.81 |
| 41 | 1054.10 | 1055.69 | 1057.28 | 1058.86 | 1060.45 | 1062.04 | 1063.63 | 1065.21 |
| 42 | 1079.50 | 1081.09 | 1082.68 | 1084.26 | 1085.85 | 1087.44 | 1089.03 | 1090.61 |
| 43 | 1104.90 | 1106.49 | 1108.08 | 1109.66 | 1111.25 | 1112.84 | 1114.43 | 1116.01 |
| 44 | 1130.30 | 1131.89 | 1133.48 | 1135.06 | 1136.65 | 1138.24 | 1139.83 | 1141.41 |
| 45 | 1155.70 | 1157.29 | 1158.88 | 1160.46 | 1162.05 | 1163.64 | 1165.23 | 1166.81 |
| 46 | 1181.10 | 1182.69 | 1184.28 | 1185.86 | 1187.45 | 1189.04 | 1190.63 | 1192.21 |
| 47 | 1206.50 | 1208.09 | 1209.68 | 1211.26 | 1212.85 | 1214.44 | 1216.03 | 1217.61 |
| 48 | 1231.90 | 1233.49 | 1235.08 | 1236.66 | 1238.25 | 1239.84 | 1241.43 | 1243.01 |
| 49 | 1257.30 | 1258.89 | 1260.48 | 1262.06 | 1263.65 | [illegible] | [illegible] | 1268.41 |
| 50 | 1282.70 | 1284.29 | 1285.88 | 1287.46 | 1289.05 | [illegible] | [illegible] | 1293.81 |

# Metric Conversion Table

**Continued**

## Pounds Avoirdupois to Kilograms

1 Pound = 0.45359 Kilograms

| Lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | ....... | 0.45 | 0.91 | 1.36 | 1.81 | 2.27 | 2.72 | 3.18 | 3.63 | 4.08 |
| 1 | 4.54 | 4.99 | 5.44 | 5.90 | 6.35 | 6.80 | 7.26 | 7.71 | 8.16 | 8.62 |
| 2 | 9.07 | 9.53 | 9.98 | 10.43 | 10.89 | 11.34 | 11.79 | 12.25 | 12.70 | 13.15 |
| 3 | 13.61 | 14.06 | 14.51 | 14.97 | 15.42 | 15.88 | 16.33 | 16.78 | 17.24 | 17.69 |
| 4 | 18.14 | 18.60 | 19.05 | 19.50 | 19.96 | 20.41 | 20.87 | 21.32 | 21.77 | 22.23 |
| 5 | 22.68 | 23.13 | 23.59 | 24.04 | 24.49 | 24.95 | 25.40 | 25.85 | 26.31 | 26.76 |
| 6 | 27.22 | 27.67 | 28.12 | 28.58 | 29.03 | 29.48 | 29.94 | 30.39 | 30.84 | 31.30 |
| 7 | 31.75 | 32.21 | 32.66 | 33.11 | 33.57 | 34.02 | 34.47 | 34.93 | 35.38 | 35.83 |
| 8 | 36.29 | 36.74 | 37.19 | 37.65 | 38.10 | 38.56 | 39.01 | 39.46 | 39.92 | 40.37 |
| 9 | 40.82 | 41.28 | 41.73 | 42.18 | 42.64 | 43.09 | 43.54 | 44.00 | 44.45 | 44.91 |
| 10 | 45.36 | 45.81 | 46.27 | 46.72 | 47.17 | 47.63 | 48.08 | 48.53 | 48.99 | 49.44 |
| 11 | 49.90 | 50.35 | 50.80 | 51.26 | 51.71 | 52.16 | 52.62 | 53.07 | 53.52 | 53.98 |
| 12 | 54.43 | 54.88 | 55.34 | 55.79 | 56.25 | 56.70 | 57.15 | 57.61 | 58.06 | 58.51 |
| 13 | 58.97 | 59.42 | 59.87 | 60.33 | 60.78 | 61.23 | 61.69 | 62.14 | 62.60 | 63.05 |
| 14 | 63.50 | 63.96 | 64.41 | 64.86 | 65.32 | 65.77 | 66.22 | 66.68 | 67.13 | 67.59 |
| 15 | 68.04 | 68.49 | 68.95 | 69.40 | 69.85 | 70.31 | 70.76 | 71.21 | 71.67 | 72.12 |
| 16 | 72.57 | 73.03 | 73.48 | 73.94 | 74.39 | 74.84 | 75.30 | 75.75 | 76.20 | 76.66 |
| 17 | 77.11 | 77.56 | 78.02 | 78.47 | 78.93 | 79.38 | 79.83 | 80.29 | 80.74 | 81.19 |
| 18 | 81.65 | 82.10 | 82.55 | 83.01 | 83.46 | 83.91 | 84.37 | 84.82 | 85.28 | 85.73 |
| 19 | 86.18 | 86.64 | 87.09 | 87.54 | 88.00 | 88.45 | 88.90 | 89.36 | 89.81 | 90.26 |
| 20 | 90.72 | 91.17 | 91.63 | 92.08 | 92.53 | 92.99 | 93.44 | 93.89 | 94.35 | 94.80 |
| 21 | 95.25 | 95.71 | 96.16 | 96.62 | 97.07 | 97.52 | 97.98 | 98.43 | 98.88 | 99.34 |
| 22 | 99.79 | 100.24 | 100.70 | 101.15 | 101.60 | 102.06 | 102.51 | 102.97 | 103.42 | 103.87 |
| 23 | 104.33 | 104.78 | 105.23 | 105.69 | 106.14 | 106.59 | 107.05 | 107.50 | 107.96 | 108.41 |
| 24 | 108.86 | 109.32 | 109.77 | 110.22 | 110.68 | 111.13 | 111.58 | 112.04 | 112.49 | 112.94 |
| 25 | 113.40 | 113.85 | 114.31 | 114.76 | 115.21 | 115.67 | 116.12 | 116.57 | 117.03 | 117.48 |
| 26 | 117.93 | 118.39 | 118.84 | 119.29 | 119.75 | 120.20 | 120.66 | 121.11 | 121.56 | 122.02 |
| 27 | 122.47 | 122.92 | 123.38 | 123.83 | 124.28 | 124.74 | 125.19 | 125.65 | 126.10 | 126.55 |
| 28 | 127.01 | 127.46 | 127.91 | 128.37 | 128.82 | 129.27 | 129.73 | 130.18 | 130.63 | 131.09 |
| 29 | 131.54 | 132.00 | 132.45 | 132.90 | 133.36 | 133.81 | 134.26 | 134.72 | 135.17 | 135.62 |
| 30 | 136.08 | 136.53 | 136.98 | 137.44 | 137.89 | 138.35 | 138.80 | 139.25 | 139.71 | 140.16 |
| 31 | 140.61 | 141.07 | 141.52 | 141.97 | 142.43 | 142.88 | 143.34 | 143.79 | 144.24 | 144.70 |
| 32 | 145.15 | 145.60 | 146.06 | 146.51 | 146.96 | 147.42 | 147.87 | 148.32 | 148.78 | 149.23 |
| 33 | 149.69 | 150.14 | 150.59 | 151.05 | 151.50 | 151.95 | 152.41 | 152.86 | 153.31 | 153.77 |
| 34 | 154.22 | 154.68 | 155.13 | 155.58 | 156.04 | 156.49 | 156.94 | 157.40 | 157.85 | 158.30 |
| 35 | 158.76 | 159.21 | 159.66 | 160.12 | 160.57 | 161.03 | 161.48 | 161.93 | 162.39 | 162.84 |
| 36 | 163.29 | 163.75 | 164.20 | 164.65 | 165.11 | 165.56 | 166.01 | 166.47 | 166.92 | 167.38 |
| 37 | 167.83 | 168.28 | 168.74 | 169.19 | 169.64 | 170.10 | 170.55 | 171.00 | 171.46 | 171.91 |
| 38 | 172.37 | 172.82 | 173.27 | 173.73 | 174.18 | 174.63 | 175.09 | 175.54 | 175.99 | 176.45 |
| 39 | 176.90 | 177.35 | 177.81 | 178.26 | 178.72 | 179.17 | 179.62 | 180.08 | 180.53 | 180.98 |
| 40 | 181.44 | 181.89 | 182.34 | 182.80 | 183.25 | 183.70 | 184.16 | 184.61 | 185.07 | 185.52 |
| 41 | 185.97 | 186.43 | 186.88 | 187.33 | 187.79 | 188.24 | 188.69 | 189.15 | 189.60 | 190.06 |
| 42 | 190.51 | 190.96 | 191.42 | 191.87 | 192.32 | 192.78 | 193.23 | 193.68 | 194.14 | 194.59 |
| 43 | 195.04 | 195.50 | 195.95 | 196.41 | 196.86 | 197.31 | 197.77 | 198.22 | 198.67 | 199.13 |
| 44 | 199.58 | 200.03 | 200.49 | 200.94 | 201.40 | 201.85 | 202.30 | 202.76 | 203.21 | 203.66 |
| 45 | 204.12 | 204.57 | 205.02 | 205.48 | 205.93 | 206.38 | 206.84 | 207.29 | 207.75 | 208.20 |
| 46 | 208.65 | 209.11 | 209.56 | 210.01 | 210.47 | 210.92 | 211.37 | 211.83 | 212.28 | 212.73 |
| 47 | 213.19 | 213.64 | 214.10 | 214.55 | 215.00 | 215.46 | 215.91 | 216.36 | 216.82 | 217.27 |
| 48 | 217.72 | 218.18 | 218.63 | 219.09 | 219.54 | 219.99 | 220.45 | 220.90 | 221.35 | 221.81 |
| 49 | 222.26 | 222.71 | 223.17 | 223.62 | 224.07 | 224.53 | 224.98 | 225.44 | 225.89 | 226.34 |

*Continued on next page.*

# Metric Conversion Table

**Continued**

## Pounds Avoirdupois to Kilograms

1 Pound = 0.45359 Kilograms

| Lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 226.80 | 227.25 | 227.70 | 228.16 | 228.61 | 229.06 | 229.52 | 229.97 | 230.42 | 230.88 |
| 51 | 231.33 | 231.79 | 232.24 | 232.69 | 233.15 | 233.60 | 234.05 | 234.51 | 234.96 | 235.41 |
| 52 | 235.87 | 236.32 | 236.78 | 237.23 | 237.68 | 238.14 | 238.59 | 239.04 | 239.50 | 239.95 |
| 53 | 240.40 | 240.86 | 241.31 | 241.76 | 242.22 | 242.67 | 243.13 | 243.58 | 244.03 | 244.49 |
| 54 | 244.94 | 245.39 | 245.85 | 246.30 | 246.75 | 247.21 | 247.66 | 248.12 | 248.57 | 249.02 |
| 55 | 249.48 | 249.93 | 250.38 | 250.84 | 251.29 | 251.74 | 252.20 | 252.65 | 253.10 | 253.56 |
| 56 | 254.01 | 254.47 | 254.92 | 255.37 | 255.83 | 256.28 | 256.73 | 257.19 | 257.64 | 258.09 |
| 57 | 258.55 | 259.00 | 259.45 | 259.91 | 260.36 | 260.82 | 261.27 | 261.72 | 262.18 | 262.63 |
| 58 | 263.08 | 263.54 | 263.99 | 264.44 | 264.90 | 265.35 | 265.81 | 266.26 | 266.71 | 267.17 |
| 59 | 267.62 | 268.07 | 268.53 | 268.98 | 269.43 | 269.89 | 270.34 | 270.79 | 271.25 | 271.70 |
| 60 | 272.16 | 272.61 | 273.06 | 273.52 | 273.97 | 274.42 | 274.88 | 275.33 | 275.78 | 276.24 |
| 61 | 276.69 | 277.14 | 277.60 | 278.05 | 278.51 | 278.96 | 279.41 | 279.87 | 280.32 | 280.77 |
| 62 | 281.23 | 281.68 | 282.13 | 282.59 | 283.04 | 283.50 | 283.95 | 284.40 | 284.86 | 285.31 |
| 63 | 285.76 | 286.22 | 286.67 | 287.12 | 287.58 | 288.03 | 288.48 | 288.94 | 289.39 | 289.85 |
| 64 | 290.30 | 290.75 | 291.21 | 291.66 | 292.11 | 292.57 | 293.02 | 293.47 | 293.93 | 294.38 |
| 65 | 294.84 | 295.29 | 295.74 | 296.20 | 296.65 | 297.10 | 297.56 | 298.01 | 298.46 | 298.92 |
| 66 | 299.37 | 299.82 | 300.28 | 300.73 | 301.19 | 301.64 | 302.09 | 302.55 | 303.00 | 303.45 |
| 67 | 303.91 | 304.36 | 304.81 | 305.27 | 305.72 | 306.17 | 306.53 | 307.08 | 307.54 | 307.99 |
| 68 | 308.44 | 308.90 | 309.35 | 309.80 | 310.26 | 310.71 | 311.16 | 311.62 | 312.07 | 312.53 |
| 69 | 312.98 | 313.43 | 313.89 | 314.34 | 314.79 | 315.25 | 315.70 | 316.15 | 316.61 | 317.06 |
| 70 | 317.51 | 317.97 | 318.42 | 318.88 | 319.33 | 319.78 | 320.24 | 320.69 | 321.14 | 321.60 |
| 71 | 322.05 | 322.50 | 322.96 | 323.41 | 323.86 | 324.32 | 324.77 | 325.23 | 325.68 | 326.13 |
| 72 | 326.59 | 327.04 | 327.49 | 327.95 | 328.40 | 328.85 | 329.31 | 329.76 | 330.22 | 330.67 |
| 73 | 331.12 | 331.58 | 332.03 | 332.48 | 332.94 | 333.39 | 333.84 | 334.30 | 334.75 | 335.20 |
| 74 | 335.66 | 336.11 | 336.57 | 337.02 | 337.47 | 337.93 | 338.38 | 338.83 | 339.29 | 339.74 |
| 75 | 340.19 | 340.65 | 341.10 | 341.56 | 342.01 | 342.46 | 342.92 | 343.37 | 343.82 | 344.28 |
| 76 | 344.73 | 345.18 | 345.64 | 346.09 | 346.54 | 347.00 | 347.45 | 347.91 | 348.36 | 348.81 |
| 77 | 349.27 | 349.72 | 350.17 | 350.63 | 351.08 | 351.53 | 351.99 | 352.44 | 352.89 | 353.35 |
| 78 | 353.80 | 354.26 | 354.71 | 355.16 | 355.62 | 356.07 | 356.52 | 356.98 | 357.43 | 357.88 |
| 79 | 358.34 | 358.79 | 359.25 | 359.70 | 360.15 | 360.61 | 361.06 | 361.51 | 361.97 | 362.42 |
| 80 | 362.87 | 363.33 | 363.78 | 364.23 | 364.69 | 365.14 | 365.60 | 366.05 | 366.50 | 366.96 |
| 81 | 367.41 | 367.86 | 368.32 | 368.77 | 369.22 | 369.68 | 370.13 | 370.59 | 371.04 | 371.49 |
| 82 | 371.95 | 372.40 | 372.85 | 373.31 | 373.76 | 374.21 | 374.67 | 375.12 | 375.57 | 376.03 |
| 83 | 376.48 | 376.94 | 377.39 | 377.84 | 378.30 | 378.75 | 379.20 | 379.66 | 380.11 | 380.56 |
| 84 | 381.02 | 381.47 | 381.92 | 382.33 | 382.83 | 383.29 | 383.74 | 384.19 | 384.65 | 385.10 |
| 85 | 385.55 | 386.01 | 386.46 | 386.91 | 387.37 | 387.82 | 388.28 | 388.73 | 389.18 | 389.64 |
| 86 | 390.09 | 390.54 | 391.00 | 391.45 | 391.90 | 392.36 | 392.81 | 393.26 | 393.72 | 394.17 |
| 87 | 394.63 | 395.08 | 395.53 | 395.99 | 396.44 | 396.89 | 397.35 | 397.80 | 398.25 | 398.71 |
| 88 | 399.16 | 399.61 | 400.07 | 400.52 | 400.98 | 401.43 | 401.88 | 402.34 | 402.79 | 403.24 |
| 89 | 403.78 | 404.15 | 404.60 | 405.06 | 405.51 | 405.97 | 406.42 | 406.87 | 407.33 | 407.78 |
| 90 | 408.23 | 408.69 | 409.14 | 409.59 | 410.05 | 410.50 | 410.95 | 411.41 | 411.86 | 412.32 |
| 91 | 412.77 | 413.22 | 413.68 | 414.13 | 414.58 | 415.14 | 415.49 | 415.94 | 416.40 | 416.85 |
| 92 | 417.31 | 417.76 | 418.21 | 418.67 | 419.12 | 419.57 | 420.03 | 420.48 | 420.93 | 421.39 |
| 93 | 421.84 | 422.29 | 422.75 | 423.20 | 423.66 | 424.11 | 424.56 | 425.02 | 425.47 | 425.92 |
| 94 | 426.38 | 426.83 | 427.28 | 427.74 | 428.19 | 428.64 | 429.10 | 429.55 | 430.01 | 430.46 |
| 95 | 430.91 | 431.37 | 431.82 | 432.27 | 432.73 | 433.18 | 433.63 | 434.09 | 434.54 | 435.00 |
| 96 | 435.45 | 435.90 | 436.36 | 436.81 | 437.26 | 437.72 | 438.17 | 438.62 | 439.08 | [illegible] |
| 97 | 439.98 | 440.44 | 440.89 | 441.35 | 441.80 | 442.25 | 442.71 | 443.16 | 443.61 | [illegible] |
| 98 | 444.52 | 444.97 | 445.43 | 445.88 | 446.33 | 446.79 | 447.24 | 447.70 | 448.1[illegible] | [illegible] |
| 99 | 449.06 | 449.51 | 449.96 | 450.42 | 450.87 | 451.32 | 451.78 | 452.23 | [illegible] | [illegible] |

## Properties of the Circle

Circumference of Circle of Diameter 1 = $\pi$ = 3.14159265
Circumference of Circle = $2\,\pi\,r$
Diameter of Circle = Circumference × 0.31831
Diameter of Circle of equal periphery as square = side × 1.27324
Side of Square of equal periphery as circle = diameter × 0.78540
Diameter of Circle circumscribed about square = side × 1.41421
Side of Square inscribed in circle = diameter × 0.70711


Arc, $a = \dfrac{\pi\, r\, A^\circ}{180} = 0.017453\, r\, A^\circ$

Angle, $A = \dfrac{180^\circ\, a}{\pi\, r} = 57.29578\, \dfrac{a}{r}$

Radius, $r = \dfrac{4\,b^2 + c^2}{8\,b}$ Diameter, $d = \dfrac{4\,b^2 + c^2}{4\,b}$

Chord, $c = 2\sqrt{2\,b\,r - b^2} = 2\,r\,\sin\dfrac{A^\circ}{2}$

Rise, $b = r - \tfrac{1}{2}\sqrt{4\,r^2 - c^2} = \dfrac{c}{2}\tan\dfrac{A^\circ}{4} = 2\,r\,\sin^2\dfrac{A}{4}$

Rise, $b = r + y - \sqrt{r^2 - x^2}$. $y = b - r + \sqrt{r^2 - x^2}$

$x = \sqrt{r^2 - (r + y - b)^2}$

$\pi = 3.14159265$, log = 0.4971499

$\dfrac{1}{\pi} = 0.3183099$, log = $\bar{1}.5028501$

$\pi^2 = 9.8696044$, log = 0.9942997

$\dfrac{1}{\pi^2} = 0.1013212$, log = $\bar{1}.0057003$

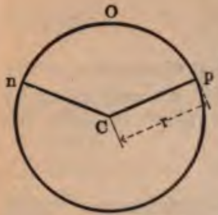
$\sqrt{\pi} = 1.7724539$, log = 0.2485749

$\sqrt{\dfrac{1}{\pi}} = 0.5641896$, log = $\bar{1}.7514251$

$\dfrac{\pi}{180} = 0.0174533$, log = $\bar{2}.2418774$

$\dfrac{180}{\pi} = 57.2957795$, log = 1.7581226

## Areas of Circular Sections

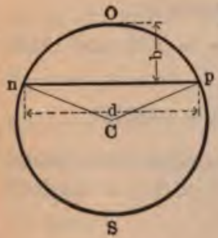



**Circular Sector,** $n\ c\ p\ o$

Area $= \frac{1}{2}$ (length of arc, $n\ o\ p \times$ radius $r$)

$= \text{Area of circle} \times \dfrac{\text{Arc, } n\ o\ p\text{, in degrees}}{360}$

$= 0.0087266 \times$ square of radius, $r^2 \times$ angle of arc, $n\ o\ p$, in degrees.




**Circular Segment,** $n\ o\ p$, less than half circle.

Area = Area of sector, $n\ c\ p\ o$, — area of triangle, $n\ c\ p$

$= \dfrac{(\text{length of arc, } n\ o\ p, \times \text{radius, } r) - (\text{radius, } r, - \text{rise, } b) \times \text{chord, } d}{2}$

**Circular Segment,** $n\ s\ p$, greater than half circle.

Area = Area of circle — area of segment, $n\ p\ o$


**Circular Segment**

Given: Rise, $c$, and chord, $d$

Area = Product of rise and chord, $c \times d$, multiplied by the coefficient given opposite the quotient of $\frac{c}{d}$:

Intermediate coefficients for values of $\frac{c}{d}$ not given in tables are obtained by interpolation.

Example—Given: Rise = 3.00 and chord = 10.39

$\frac{c}{d} = \frac{3.00}{10.39} = 0.2887.$ Coefficient $= 0.7092$

Area $= c \times d \times$ coeff. $= 3.00 \times$ [illegible] 0.7092 = 22.10576

# Areas of Circular Sections

**Continued**

## Circular Segment


Given: Rise, $c$, and diameter, $d = 2r$

Area = Square of diameter, $d^2$, multiplied by the coefficient given opposite the quotient of $\frac{c}{d}$

Intermediate coefficients for values of $\frac{c}{d}$ not given in tables are obtained by interpolation.

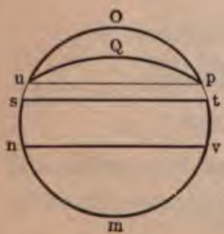
Example—Given: Rise = 3.78 and diameter = 8.25

$$\frac{c}{d} = 3.78 \div 8.25 = 0.458181$$

Coefficient by interpolation = 0.350929

Area = $d^2 \times$ coeff. = $8.25 \times 8.25 \times 0.350929$ = 23.8851

---




## Circular Zone, *s t v n*

Area = Area of circle — (area of segment, *s o t* + area of segment, *n m v*)

## Circular Lune, *u o p q*

Area = Segment, *u o p* — segment *u q p*

## Areas of Plane Figures

Triangle: Base × ½ perpendicular height

$\sqrt{s(s-a)(s-b)(s-c)}$,

$s$ = ½ sum of the three sides, $a$, $b$ and $c$

Trapezium: Sum of area of the two triangles

Trapezoid: ½ sum of parallel sides × perpendicular height

Parallelogram: Base × perpendicular height

Regular Polygon: ½ sum of sides × inside radius

Circle: $\pi r^2 = 0.78540 \times \text{diameter}^2 = 0.07958 \times \text{circumference}^2$

Sector of Circle: $\frac{\pi r^2 A^\circ}{360} = 0.0087266\, r^2 A^\circ$ = arc × ½ radius

Segment of Circle $\frac{r^2}{2}\left(\frac{\pi A^\circ}{180} - \sin A^\circ\right)$

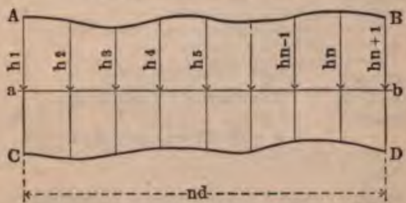
Circle of same area as square: diameter = side × 1.12838

Square of same area as circle: side = diameter × 0.88623

Ellipse: Long diameter × short diameter × 0.78540

Parabola: Base × ⅔ perpendicular height

### Irregular Plane Surface




Divide any plane surface $A$, $B$, $C$, $D$, along a line $a$–$b$ into an even number, $n$, of parallel and sufficiently small strips, $d$, whose ordinates are $h_1$, $h_2$, $h_3$, $h_4$, $h_5$ ...... $h_{n-1}$, $h_n$, $h_{n+1}$, and considering contours between three ordinates as parabolic curves, then for section $ABCD$,

$$\text{Area} = \frac{d}{3}\left[h_1 + h_{n+1} + 4(h_2 + h_4 + h_6 \ldots + h_n) + 2(h_3 + h_5 + h_7 \ldots + h_{n-1})\right]$$

or, approximately, Area = Sum of ordinates ×

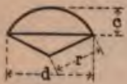
# Surface and Volume of Solids

**S = Lateral or Convex Surface V = Volume**

### Sphere

$S = 4\ \pi r^2 = \pi d^2 = 3.14159265\ d^2$

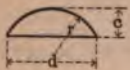
$V = \frac{4}{3}\ \pi r^3 = \frac{1}{6}\ \pi d^3 = 0.52359878\ d^3$



### Spherical Sector

$S = \frac{1}{2}\ \pi r\ (4c + d)$

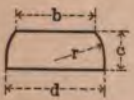
$V = \frac{2}{3}\ \pi r^2 c$



### Spherical Segment

$S = 2\ \pi rc = \frac{1}{4}\ \pi\ (4c^2 + d^2)$

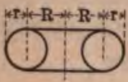
$V = \frac{1}{3}\ \pi c^2\ (3r - c) = \frac{1}{24}\ \pi c\ (3\ d^2 + 4\ c^2)$



### Spherical Zone

$S = 2\ \pi r c$

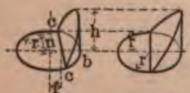
$V = \frac{1}{24}\ \pi c\ (3b^2 + 3d^2 + 4c^2)$



### Circular Ring

$S = 4\ \pi^2 Rr$

$V = 2\ \pi^2 Rr^2$

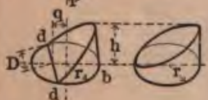


### Ungula of Right, Regular Cylinder

Base = Segment $c\ b\ c$

$S = (2\ r\ n - f \times \text{arc},\ c\ b\ c)\ \frac{h}{r - f}$ Base = Half Circle

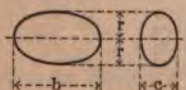
$V = (\frac{2}{3}\ n^3 - f \times \text{area},\ c\ b\ c)\ \frac{h}{r - f}$ $S = 2\ r\ h$ $V = \frac{2}{3}\ r^2\ h$



Base = Segment $d\ b\ d$

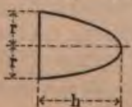
$S = (2\ r\ D + q \times \text{arc},\ d\ b\ d)\ \frac{h}{r + q}$ Base = Circle

$V = (\frac{2}{3}\ D^3 + q \times \text{area},\ d\ b\ d)\ \frac{h}{r + q}$ $S = r\ \pi\ h$ $V = \frac{1}{2}\ r^2\ \pi\ h$



### Ellipsoid

$V = \frac{1}{3}\ \pi\ r\ b\ c$



### Paraboloid

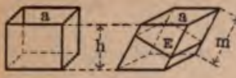
$V = \frac{1}{2}\ \pi\ r^2\ h$

*Ratio of corresponding volumes of a cone, paraboloid sphere, and cylinder of equal height* : $\frac{1}{3} : \frac{1}{2} : \frac{2}{3} : 1$.

# Surface and Volume of Solids

**Continued**

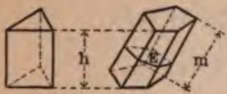
## S=Lateral or Convex Surface V=Volume




**Parallelopiped**

$V$ = Area of any face $a$ × perpendicular distance $h$ to the opposite face.

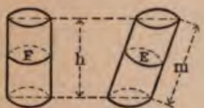
$V$ = Area of cross section $E$ (perpendicular to the sides) × actual length $m$.




**Prism, Right or Oblique, Regular or Irregular**

$V$ = Area of one end × perpendicular distance $h$ to the other end.

$V$ = Area of cross section $E$ (perpendicular to the sides) × actual length $m$.

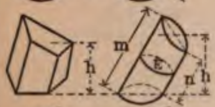



**Cylinder, Right or Oblique, Circular or Elliptic**

$S$ = Circumference (perpendicular to sides) as at $F$, or $E$, × actual length $h$ or $m$.

$V$ = Area of one end × perpendicular distance $h$ to other end.

$V$ = Area of cross section (perpendicular to sides) as at $F$, or $E$ × actual length $h$ or $m$.

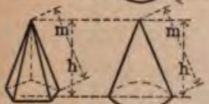



**Frustum of any Prism or Cylinder**

$V$ = Area of base × perpendicular distance $h$ from base to center of gravity of other end.

**For Cylinder**

$V$ = Area of cross section $E$ (perpendicular to sides) × ½ $(m + n)$.




**Pyramid or Cone, Right or Regular**

$V$ = Area of base × ⅓ perpendicular height $h$.

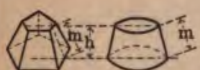
$S$ = Perimeter of base × ½ slant height $m$.


**Pyramid or Cone, Right or Oblique, Regular or Irregular**

$V$ = Area of base × ⅓ perpendicular height $h$.

$V$ = ⅓ volume of prism or cylinder having same area of base and same perpendicular height.

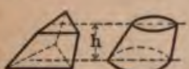
$V$ = ½ volume of hemisphere of same base and same perpendicular height.




**Frustum of Pyramid or Cone Right and Regular Parallel Ends**

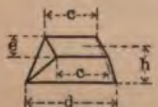
$S$ = Sum of perimeter of base and top × ½ slant height $m$.

$V$ = ⅓ × perpendicular height × (area of top + area of base + $\sqrt{\text{area of top} \times \text{area of base}}$).




**Frustum of any Pyramid or Cone, Parallel Ends**

$V$ = ⅓ × perpendicular height $h$ × (area of top + area of base + $\sqrt{\text{area of top} \times \text{area of base}}$).




**Wedge, Parallelogram Face**

$V$ = ⅙ (sum of three edges $c$, $d$, $c$ × perpendicular height $h$ × perpendicular width $e$).

# Trigonometrical Formulae

Radius, $1 = \sin^2 A + \cos^2 A$
$= \sin A \operatorname{cosec} A = \cos A \sec A = \tan A \cot A$


Sine $A = \dfrac{\cos A}{\cot A} = \dfrac{1}{\operatorname{cosec} A} = \cos A \tan A = \sqrt{1-\cos^2 A}$

Cosine $A = \dfrac{\sin A}{\tan A} = \dfrac{r}{\sec A} = \sin A \cot A = \sqrt{1-\sin^2 A}$

Tangent $A = \dfrac{\sin A}{\cos A} = \dfrac{1}{\cot A} = \sin A \sec A$

Cotangent $A = \dfrac{\cos A}{\sin A} = \dfrac{1}{\tan A} = \cos A \operatorname{cosec} A$

Secant $A = \dfrac{\tan A}{\sin A} = \dfrac{1}{\cos A}$

Cosecant $A = \dfrac{\cot A}{\cos A} = \dfrac{1}{\sin A}$

$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$ $\qquad \tan(A \pm B) = \dfrac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$ $\qquad \cot(A + B) = \dfrac{\cot A \cot B \mp 1}{\cot B \pm \cot A}$

$\sin A + \sin B = 2 \sin \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B)$ $\qquad \tan A + \tan B = \dfrac{\sin(A+B)}{\cos A \cos B}$

$\sin A - \sin B = 2 \cos \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B)$ $\qquad \tan A - \tan B = \dfrac{\sin(A-B)}{\cos A \cos B}$

$\cos A + \cos B = 2 \cos \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B)$ $\qquad \cot A + \cot B = \dfrac{\sin(B+A)}{\sin A \sin B}$

$\cos B - \cos A = 2 \sin \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B)$ $\qquad \cot A - \cot B = \dfrac{\sin(B-A)}{\sin A \sin B}$

$\sin 2A = 2 \sin A \cos A$ $\qquad \tan 2A = \dfrac{2 \tan A}{1-\tan^2 A}$

$\cos 2A = \cos^2 A - \sin^2 A$ $\qquad \cot 2A = \dfrac{\cot^2 A - 1}{2 \cot A}$

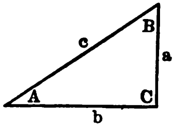
$\sin \tfrac{1}{2}A = \sqrt{\dfrac{1-\cos A}{2}}$ $\quad \cos \tfrac{1}{2}A = \sqrt{\dfrac{1+\cos A}{2}}$ $\quad \tan \tfrac{1}{2}A = \dfrac{\sin A}{1+\cos A}$ $\quad \cot \tfrac{1}{2}A = \dfrac{\sin A}{1-\cos A}$

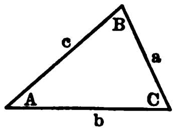
$\sin^2 A = \dfrac{1-\cos 2A}{2}$ $\quad \cos^2 A = \dfrac{1+\cos 2A}{2}$ $\quad \tan^2 A = \dfrac{1-\cos 2A}{1+\cos 2A}$ $\quad \cot^2 A = \dfrac{1+\cos 2A}{1-\cos 2A}$

$\sin^2 A - \sin^2 B = \sin(A+B) \sin(A-B)$ $\qquad \cos^2 A - \sin^2 B = \cos(A+B) \cos(A-B)$

$\dfrac{\sin A \pm \sin B}{\cos A + \cos B} = \tan \tfrac{1}{2}(A \pm B)$ $\qquad \dfrac{\sin A \pm \sin B}{\cos B - \cos A} = \cot \tfrac{1}{2}(A \mp B)$

# Trigonometrical Solution of Triangles




$$S = \frac{a+b+c}{2}$$

| Given | Sought | Formulae | | |
|---|---|---|---|---|
| | | **RIGHT-ANGLED TRIANGLES** | | |
| a, c | A, B, b | $\sin A = \frac{a}{c}$, | $\cos B = \frac{a}{c}$, | $b = \sqrt{c^2 - a^2}$ |
| | Area | $\text{Area} = \frac{a}{2}\sqrt{c^2 - a^2}$ | | |
| a, b | A, B, c | $\tan A = \frac{a}{b}$, | $\tan B = \frac{b}{a}$, | $c = \sqrt{a^2 + b^2}$ |
| | Area | $\text{Area} = \frac{a\,b}{2}$ | | |
| A, a | B, b, c | $B = 90° - A$, | $b = a \cot A$, | $c = \frac{a}{\sin A}$ |
| | Area | $\text{Area} = \frac{a^2 \cot A}{2}$ | | |
| A, b | B, a, c | $B = 90° - A$, | $a = b \tan A$, | $c = \frac{b}{\cos A}$ |
| | Area | $\text{Area} = \frac{b^2 \tan A}{2}$ | | |
| A, c | B, a, b | $B = 90° - A$, | $a = c \sin A$, | $b = c \cos A$ |
| | Area | $\text{Area} = \frac{c^2 \sin A \cos A}{2}$ or $\frac{c^2 \sin 2A}{4}$ | | |
| | | **OBLIQUE-ANGLED TRIANGLES** | | |
| a, b, c | A | $\sin \tfrac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{b\,c}}$, | $\cos \tfrac{1}{2} A = \sqrt{\frac{s(s-a)}{b\,c}}$, | $\tan \tfrac{1}{2} A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$ |
| | B | $\sin \tfrac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{a\,c}}$, | $\cos \tfrac{1}{2} B = \sqrt{\frac{s(s-b)}{a\,c}}$, | $\tan \tfrac{1}{2} B = \sqrt{\frac{(s-a)(s-c)}{s(s-b)}}$ |
| | C | $\sin \tfrac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{a\,b}}$, | $\cos \tfrac{1}{2} C = \sqrt{\frac{s(s-c)}{a\,b}}$, | $\tan \tfrac{1}{2} C = \sqrt{\frac{(s-a)(s-b)}{s(s-c)}}$ |
| | Area | $\text{Area} = \sqrt{s(s-a)(s-b)(s-c)}$ | | |

Continued on next page

# Trigonometrical Solution of Triangles

### Continued

| Given | Sought | Formulae |
|---|---|---|
| | | **OBLIQUE-ANGLED TRIANGLES** |
| a, A, b | b, c | $b = \dfrac{a \sin B}{\sin A}$ $\quad c = \dfrac{a \sin C}{\sin A} = \dfrac{a \sin (A+B)}{\sin A}$ |
| | Area | $\text{Area} = \frac{1}{2} a\, b \sin C = \dfrac{a^2 \sin B \sin C}{2 \sin A}$ |
| a, b, A | B | $\sin B = \dfrac{b \sin A}{a}$ |
| | c | $c = \dfrac{a \sin C}{\sin A} = \dfrac{b \sin C}{\sin B} = \sqrt{a^2 + b^2 - 2ab \cos C}$ |
| | Area | $\text{Area} = \frac{1}{2} a\, b \sin C$ |
| a, b, C | A | $\tan A = \dfrac{a \sin C}{b - a \cos C}$, $\quad \tan \frac{1}{2}(A-B) = \dfrac{a-b}{a+b} \cot \frac{1}{2} C$ |
| | c | $c = \sqrt{a^2 + b^2 - 2ab \cos C} = \dfrac{a \sin C}{\sin A}$ |
| | Area | $\text{Area} = \frac{1}{2} ab \sin C$ |

$a^2 = b^2 + c^2 - 2bc \cos A$, $b^2 = a^2 + c^2 - 2ac \cos B$ $c^2 = a^2 + b^2 - 2ab \cos C$

# Comparison of Standard Linear Units

## Approximate Values in Common Fractions, Decimal Equivalents or Both

| A | One Millim. Equals | One Centim. Equals | One Inch Equals | One Decim. Equals | One Foot Equals | One Yard Equals | One Meter Equals | One Rod Equals | One Chain Equals | One Hect'm. Equals | One Furlong Equals | One Kilom. Equals | One Mile Equals | One Knot Equals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Millimeters | 1 | 10 | 25.4 | 100 | 304.8 | 914.4 | 1000 | 5029.2 | 20116.8 | 100,000 | 201,168 | 1,000,000 | 1,609,344 | 1,853,256 |
| Centimeters | 1/10 0.1 | 1 | 2.54 | 10 | 30.48 | 91.44 | 100 | 502.9 | 2011.68 | 10,000 | 20,116.8 | 100,000 | 160,934 | 185,325 |
| Inches | 1/25 0.03937 | 4/10 0.3937 | 1 | 3.937 | 12 | 36 | 39.37 | 198 | 792 | 3937 | 7920 | 39,370 | 63,360 | 72,963 |
| Decimeters | 1/100 0.01 | 1/10 0.1 | 1/4 0.254 | 1 | 3.048 | 9.144 | 10 | 50.29 | 201.17 | 1000 | 2011.7 | 10,000 | 16,093 | 18,532.5 |
| Feet | 1/300 0.00328 | 1/30 0.03281 | 1/12 0.08333 | 1/3 0.32808 | 1 | 3 | 3.2808 | 16.5 | 66 | 328.08 | 660 | 3280.8 | 5280 | 6080.2 |
| Yards | 1/900 0.00109 | 1/100 0.01094 | 1/36 0.0278 | 1/9 0.10936 | 1/3 0.33333 | 1 | 1.0936 | 5.5 | 22 | 109.36 | 220 | 1093.6 | 1760 | 2026.7 |
| Meters | 1/1000 0.001 | 1/100 0.01 | 1/40 0.0254 | 1/10 0.1 | 3/10 0.3048 | 9/10 0.9144 | 1 | 5.0292 | 20.116 | 100 | 201.17 | 1000 | 1609.3 | 1853.3 |
| Rods | 1/5000 0.0002 | 1/500 0.00199 | 1/200 0.00505 | 1/50 0.01988 | 2/33 0.06061 | 2/11 0.18182 | 1/5 0.19884 | 1 | 4 | 19.884 | 40 | 198.84 | 320 | 368.5 |
| Chains | 1/20,000 0.00005 | 1/2000 0.0005 | 1/800 0.00126 | 1/200 0.00497 | 1/66 0.01515 | 1/22 0.04545 | 1/20 0.04971 | 1/4 0.25 | 1 | 4.971 | 10 | 49.71 | 80 | 92.12 |
| Hectometers | 1/100,000 0.00001 | 1/10,000 0.0001 | 1/4000 0.000254 | 1/1000 0.001 | 3/1000 0.00305 | 1/110 0.009114 | 1/100 0.01 | 1/20 0.05029 | 1/5 0.20117 | 1 | 2.0117 | 10 | 16.093 | 18.53 |
| Furlongs | 1/200,000 | 1/20,000 0.00005 | 1/7700 0.00013 | 1/2000 0.0005 | 1/650 0.00152 | 1/220 0.00455 | 1/200 0.00497 | 1/40 0.025 | 1/10 0.1 | 1/2 0.4971 | 1 | 4.971 | 8 | 9.212 |
| Kilometers | 1/1,000,000 | 1/100,000 0.00001 | 1/40,000 0.000025 | 1/10000 0.0001 | 3/10000 0.00031 | 1/1100 0.00091 | 1/1000 0.001 | 1/200 0.00503 | 1/50 0.02012 | 1/10 0.1 | 1/5 0.20117 | 1 | 1.6093 | 1.853 |
| es | | | 1/63,000 | | 1/5280 | 1/1760 0.00057 | 1/1600 0.00062 | 1/320 0.00313 | 1/80 0.0125 | 1/16 0.06214 | 1/8 0.125 | 5/8 0.62137 | 1 | 1.152 |
| ts S.) | | | 1/73,000 | | 3/20000 0.00016 | 1/2000 0.00049 | 1/1850 0.00054 | 1/370 0.00271 | 1/92 0.01085 | 1/19 0.05396 | 1/11 0.10855 | 7/13 0.53959 | 7/8 0.8684 | 1 |

NOTE:—At the point where any vertical column crosses any horizontal column will be found the value of the unit named at head of the vertical column expressed in terms of the unit named under A opposite the horizontal column.
Thus, 1 Meter = 1.0936 Yards; 1 Foot = 0.3048 Meter.

# Natural Tangents and Cotangents

| Degrees | Tangents | | | | | | | Cotangents |
|---|---|---|---|---|---|---|---|---|
| | 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | |
| 0 | 0.00000 | 0.00291 | 0.00582 | 0.00873 | 0.01164 | 0.01455 | 0.01746 | 89 |
| 1 | 0.01746 | 0.02036 | 0.02328 | 0.02619 | 0.02910 | 0.03201 | 0.03492 | 88 |
| 2 | 0.03492 | 0.03783 | 0.04075 | 0.04366 | 0.04658 | 0.04949 | 0.05241 | 87 |
| 3 | 0.05241 | 0.05533 | 0.05824 | 0.06116 | 0.06408 | 0.06700 | 0.06993 | 86 |
| 4 | 0.06993 | 0.07285 | 0.07578 | 0.07870 | 0.08163 | 0.08456 | 0.08749 | 85 |
| 5 | 0.08749 | 0.09042 | 0.09335 | 0.09629 | 0.09923 | 0.10216 | 0.10510 | 84 |
| 6 | 0.10510 | 0.10805 | 0.11099 | 0.11394 | 0.11688 | 0.11983 | 0.12278 | 83 |
| 7 | 0.12278 | 0.12574 | 0.12869 | 0.13165 | 0.13461 | 0.13758 | 0.14054 | 82 |
| 8 | 0.14054 | 0.14351 | 0.14648 | 0.14945 | 0.15243 | 0.15540 | 0.15838 | 81 |
| 9 | 0.15838 | 0.16137 | 0.16435 | 0.16734 | 0.17033 | 0.17333 | 0.17633 | 80 |
| 10 | 0.17633 | 0.17933 | 0.18233 | 0.18534 | 0.18835 | 0.19136 | 0.19438 | 79 |
| 11 | 0.19438 | 0.19740 | 0.20042 | 0.20345 | 0.20648 | 0.20952 | 0.21256 | 78 |
| 12 | 0.21256 | 0.21560 | 0.21864 | 0.22169 | 0.22475 | 0.22781 | 0.23087 | 77 |
| 13 | 0.23087 | 0.23393 | 0.23700 | 0.24008 | 0.24316 | 0.24624 | 0.24933 | 76 |
| 14 | 0.24933 | 0.25242 | 0.25552 | 0.25862 | 0.26172 | 0.26483 | 0.26795 | 75 |
| 15 | 0.26795 | 0.27107 | 0.27419 | 0.27732 | 0.28046 | 0.28360 | 0.28675 | 74 |
| 16 | 0.28675 | 0.28990 | 0.29305 | 0.29621 | 0.29938 | 0.30255 | 0.30573 | 73 |
| 17 | 0.30573 | 0.30891 | 0.31210 | 0.31530 | 0.31850 | 0.32171 | 0.32492 | 72 |
| 18 | 0.32492 | 0.32814 | 0.33136 | 0.33460 | 0.33783 | 0.34108 | 0.34433 | 71 |
| 19 | 0.34433 | 0.34758 | 0.35085 | 0.35412 | 0.35740 | 0.36068 | 0.36397 | 70 |
| 20 | 0.36397 | 0.36727 | 0.37057 | 0.37388 | 0.37720 | 0.38053 | 0.38386 | 69 |
| 21 | 0.38386 | 0.38721 | 0.39055 | 0.39391 | 0.39727 | 0.40065 | 0.40403 | 68 |
| 22 | 0.40403 | 0.40741 | 0.41081 | 0.41421 | 0.41763 | 0.42105 | 0.42447 | 67 |
| 23 | 0.42447 | 0.42791 | 0.43136 | 0.43481 | 0.43828 | 0.44175 | 0.44523 | 66 |
| 24 | 0.44523 | 0.44872 | 0.45222 | 0.45573 | 0.45924 | 0.46277 | 0.46631 | 65 |
| 25 | 0.46631 | 0.46985 | 0.47341 | 0.47698 | 0.48055 | 0.48414 | 0.48773 | 64 |
| 26 | 0.48773 | 0.49134 | 0.49495 | 0.49858 | 0.50222 | 0.50587 | 0.50953 | 63 |
| 27 | 0.50953 | 0.51320 | 0.51688 | 0.52057 | 0.52427 | 0.52798 | 0.53171 | 62 |
| 28 | 0.53171 | 0.53545 | 0.53920 | 0.54296 | 0.54674 | 0.55051 | 0.55431 | 61 |
| 29 | 0.55431 | 0.55812 | 0.56194 | 0.56577 | 0.56962 | 0.57348 | 0.57735 | 60 |
| 30 | 0.57735 | 0.58124 | 0.58513 | 0.58905 | 0.59297 | 0.59691 | 0.60086 | 59 |
| 31 | 0.60086 | 0.60483 | 0.60881 | 0.61280 | 0.61681 | 0.62083 | 0.62487 | 58 |
| 32 | 0.62487 | 0.62892 | 0.63299 | 0.63707 | 0.64117 | 0.64528 | 0.64941 | 57 |
| 33 | 0.64941 | 0.65355 | 0.65771 | 0.66189 | 0.66608 | 0.67028 | 0.67451 | 56 |
| 34 | 0.67451 | 0.67875 | 0.68301 | 0.68728 | 0.69157 | 0.69588 | 0.70021 | 55 |
| 35 | 0.70021 | 0.70455 | 0.70891 | 0.71329 | 0.71769 | 0.72211 | 0.72654 | 54 |
| 36 | 0.72654 | 0.73100 | 0.73547 | 0.73996 | 0.74447 | 0.74900 | 0.75355 | 53 |
| 37 | 0.75355 | 0.75812 | 0.76272 | 0.76733 | 0.77196 | 0.77661 | 0.78129 | 52 |
| 38 | 0.78129 | 0.78598 | 0.79070 | 0.79544 | 0.80020 | 0.80498 | 0.80978 | 51 |
| 39 | 0.80978 | 0.81461 | 0.81946 | 0.82434 | 0.82923 | 0.83415 | 0.83910 | 50 |
| 40 | 0.83910 | 0.84407 | 0.84906 | 0.85408 | 0.85912 | 0.86419 | 0.86929 | 49 |
| 41 | 0.86929 | 0.87441 | 0.87955 | 0.88473 | 0.88992 | 0.89515 | 0.90040 | 48 |
| 42 | 0.90040 | 0.90569 | 0.91099 | 0.91633 | 0.92170 | 0.92709 | 0.93252 | 47 |
| 43 | 0.93252 | 0.93797 | 0.94345 | 0.94896 | 0.95451 | 0.96008 | 0.96569 | 46 |
| 44 | 0.96569 | 0.97133 | 0.97700 | 0.98270 | 0.98843 | 0.99420 | 1.00000 | 45 |
| Tangents | 60′ | 50′ | 40′ | 30′ | 20′ | 10′ | 0′ | Degrees |
| | Cotangents | | | | | | | |

# Natural Tangents and Cotangents

| Degrees | Cotangents | | | | | | | Tan-gents |
|---|---|---|---|---|---|---|---|---|
| | 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | |
| 0 | ∞ | 343.77371 | 171.88540 | 114.58865 | 85.93979 | 68.75009 | 57.28996 | 89 |
| 1 | 57.28996 | 49.10388 | 42.96408 | 38.18846 | 34.36777 | 31.24158 | 28.63625 | 88 |
| 2 | 28.63625 | 26.43160 | 24.54176 | 22.90377 | 21.47040 | 20.20555 | 19.08114 | 87 |
| 3 | 19.08114 | 18.07498 | 17.16934 | 16.34986 | 15.60478 | 14.92442 | 14.30067 | 86 |
| 4 | 14.30067 | 13.72674 | 13.19688 | 12.70621 | 12.25051 | 11.82617 | 11.43005 | 85 |
| 5 | 11.43005 | 11.05943 | 10.71191 | 10.38540 | 10.07803 | 9.78817 | 9.51436 | 84 |
| 6 | 9.51436 | 9.25530 | 9.00983 | 8.77689 | 8.55555 | 8.34496 | 8.14435 | 83 |
| 7 | 8.14435 | 7.95302 | 7.77035 | 7.59575 | 7.42871 | 7.26873 | 7.11537 | 82 |
| 8 | 7.11537 | 6.96823 | 6.82694 | 6.69116 | 6.56055 | 6.43484 | 6.31375 | 81 |
| 9 | 6.31375 | 6.19703 | 6.08444 | 5.97576 | 5.87080 | 5.76937 | 5.67128 | 80 |
| 10 | 5.67128 | 5.57638 | 5.48451 | 5.39552 | 5.30928 | 5.22566 | 5.14455 | 79 |
| 11 | 5.14455 | 5.06584 | 4.98940 | 4.91516 | 4.84300 | 4.77286 | 4.70463 | 78 |
| 12 | 4.70463 | 4.63825 | 4.57363 | 4.51071 | 4.44942 | 4.38969 | 4.33148 | 77 |
| 13 | 4.33148 | 4.27471 | 4.21933 | 4.16530 | 4.11256 | 4.06107 | 4.01078 | 76 |
| 14 | 4.01078 | 3.96165 | 3.91364 | 3.86671 | 3.82083 | 3.77595 | 3.73205 | 75 |
| 15 | 3.73205 | 3.68909 | 3.64705 | 3.60588 | 3.56557 | 3.52609 | 3.48741 | 74 |
| 16 | 3.48741 | 3.44951 | 3.41236 | 3.37594 | 3.34023 | 3.30521 | 3.27085 | 73 |
| 17 | 3.27085 | 3.23714 | 3.20406 | 3.17159 | 3.13972 | 3.10842 | 3.07768 | 72 |
| 18 | 3.07768 | 3.04749 | 3.01783 | 2.98869 | 2.96004 | 2.93189 | 2.90421 | 71 |
| 19 | 2.90421 | 2.87700 | 2.85023 | 2.82391 | 2.79802 | 2.77254 | 2.74748 | 70 |
| 20 | 2.74748 | 2.72281 | 2.69853 | 2.67462 | 2.65109 | 2.62791 | 2.60509 | 69 |
| 21 | 2.60509 | 2.58261 | 2.56046 | 2.53865 | 2.51715 | 2.49597 | 2.47509 | 68 |
| 22 | 2.47509 | 2.45451 | 2.43422 | 2.41421 | 2.39449 | 2.37504 | 2.35585 | 67 |
| 23 | 2.35585 | 2.33693 | 2.31826 | 2.29984 | 2.28167 | 2.26374 | 2.24604 | 66 |
| 24 | 2.24604 | 2.22857 | 2.21132 | 2.19430 | 2.17749 | 2.16090 | 2.14451 | 65 |
| 25 | 2.14451 | 2.12832 | 2.11233 | 2.09654 | 2.08094 | 2.06553 | 2.05030 | 64 |
| 26 | 2.05030 | 2.03526 | 2.02039 | 2.00569 | 1.99116 | 1.97680 | 1.96261 | 63 |
| 27 | 1.96261 | 1.94858 | 1.93470 | 1.92098 | 1.90741 | 1.89400 | 1.88073 | 62 |
| 28 | 1.88073 | 1.86760 | 1.85462 | 1.84177 | 1.82907 | 1.81649 | 1.80405 | 61 |
| 29 | 1.80405 | 1.79174 | 1.77955 | 1.76749 | 1.75556 | 1.74375 | 1.73205 | 60 |
| 30 | 1.73205 | 1.72047 | 1.70901 | 1.69766 | 1.68643 | 1.67530 | 1.66428 | 59 |
| 31 | 1.66428 | 1.65337 | 1.64256 | 1.63185 | 1.62125 | 1.61074 | 1.60033 | 58 |
| 32 | 1.60033 | 1.59002 | 1.57981 | 1.56969 | 1.55966 | 1.54972 | 1.53987 | 57 |
| 33 | 1.53987 | 1.53010 | 1.52043 | 1.51084 | 1.50133 | 1.49190 | 1.48256 | 56 |
| 34 | 1.48256 | 1.47330 | 1.46411 | 1.45501 | 1.44598 | 1.43703 | 1.42815 | 55 |
| 35 | 1.42815 | 1.41934 | 1.41061 | 1.40195 | 1.39336 | 1.38484 | 1.37638 | 54 |
| 36 | 1.37638 | 1.36800 | 1.35968 | 1.35142 | 1.34323 | 1.33511 | 1.32704 | 53 |
| 37 | 1.32704 | 1.31904 | 1.31110 | 1.30323 | 1.29541 | 1.28764 | 1.27994 | 52 |
| 38 | 1.27994 | 1.27230 | 1.26471 | 1.25717 | 1.24969 | 1.24227 | 1.23490 | 51 |
| 39 | 1.23490 | 1.22758 | 1.22031 | 1.21310 | 1.20593 | 1.19882 | 1.19175 | 50 |
| 40 | 1.19175 | 1.18474 | 1.17777 | 1.17085 | 1.16398 | 1.15715 | 1.15037 | 49 |
| 41 | 1.15037 | 1.14363 | 1.13694 | 1.13029 | 1.12369 | 1.11713 | 1.11061 | 48 |
| 42 | 1.11061 | 1.10414 | 1.09770 | 1.09131 | 1.08496 | 1.07864 | 1.07237 | 47 |
| 43 | 1.07237 | 1.06613 | 1.05994 | 1.05378 | 1.04766 | 1.04158 | 1.03553 | 46 |
| 44 | 1.03553 | 1.02952 | 1.02355 | 1.01761 | 1.01170 | 1.00583 | 1.00000 | 45 |
| Cotan-gents | 60′ | 50′ | 40′ | 30′ | 20′ | 10′ | 0′ | Degrees |
| | Tangents | | | | | | | |

# Natural Sines and Cosines

| Degrees | Sines 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | Cosines |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.00000 | 0.00291 | 0.00582 | 0.00873 | 0.01164 | 0.01454 | 0.01745 | 89 |
| 1 | 0.01745 | 0.02036 | 0.02327 | 0.02618 | 0.02908 | 0.03199 | 0.03490 | 88 |
| 2 | 0.03490 | 0.03781 | 0.04071 | 0.04362 | 0.04653 | 0.04943 | 0.05234 | 87 |
| 3 | 0.05234 | 0.05524 | 0.05814 | 0.06105 | 0.06395 | 0.06685 | 0.06976 | 86 |
| 4 | 0.06976 | 0.07266 | 0.07556 | 0.07846 | 0.08136 | 0.08426 | 0.08716 | 85 |
| 5 | 0.08716 | 0.09005 | 0.09295 | 0.09585 | 0.09874 | 0.10164 | 0.10453 | 84 |
| 6 | 0.10453 | 0.10742 | 0.11031 | 0.11320 | 0.11609 | 0.11898 | 0.12187 | 83 |
| 7 | 0.12187 | 0.12476 | 0.12764 | 0.13053 | 0.13341 | 0.13629 | 0.13917 | 82 |
| 8 | 0.13917 | 0.14205 | 0.14493 | 0.14781 | 0.15069 | 0.15356 | 0.15643 | 81 |
| 9 | 0.15643 | 0.15931 | 0.16218 | 0.16505 | 0.16792 | 0.17078 | 0.17365 | 80 |
| 10 | 0.17365 | 0.17651 | 0.17937 | 0.18224 | 0.18509 | 0.18795 | 0.19081 | 79 |
| 11 | 0.19081 | 0.19366 | 0.19652 | 0.19937 | 0.20222 | 0.20507 | 0.20791 | 78 |
| 12 | 0.20791 | 0.21076 | 0.21360 | 0.21644 | 0.21928 | 0.22212 | 0.22495 | 77 |
| 13 | 0.22495 | 0.22778 | 0.23062 | 0.23345 | 0.23627 | 0.23910 | 0.24192 | 76 |
| 14 | 0.24192 | 0.24474 | 0.24756 | 0.25038 | 0.25320 | 0.25601 | 0.25882 | 75 |
| 15 | 0.25882 | 0.26163 | 0.26443 | 0.26724 | 0.27004 | 0.27284 | 0.27564 | 74 |
| 16 | 0.27564 | 0.27843 | 0.28123 | 0.28402 | 0.28680 | 0.28959 | 0.29237 | 73 |
| 17 | 0.29237 | 0.29515 | 0.29793 | 0.30071 | 0.30348 | 0.30625 | 0.30902 | 72 |
| 18 | 0.30902 | 0.31178 | 0.31454 | 0.31730 | 0.32006 | 0.32282 | 0.32557 | 71 |
| 19 | 0.32557 | 0.32832 | 0.33106 | 0.33381 | 0.33655 | 0.33929 | 0.34202 | 70 |
| 20 | 0.34202 | 0.34475 | 0.34748 | 0.35021 | 0.35293 | 0.35565 | 0.35837 | 69 |
| 21 | 0.35837 | 0.36108 | 0.36379 | 0.36650 | 0.36921 | 0.37191 | 0.37461 | 68 |
| 22 | 0.37461 | 0.37730 | 0.37999 | 0.38268 | 0.38537 | 0.38805 | 0.39073 | 67 |
| 23 | 0.39073 | 0.39341 | 0.39608 | 0.39875 | 0.40142 | 0.40408 | 0.40674 | 66 |
| 24 | 0.40674 | 0.40939 | 0.41204 | 0.41469 | 0.41734 | 0.41998 | 0.42262 | 65 |
| 25 | 0.42262 | 0.42525 | 0.42788 | 0.43051 | 0.43313 | 0.43575 | 0.43837 | 64 |
| 26 | 0.43837 | 0.44098 | 0.44359 | 0.44620 | 0.44880 | 0.45140 | 0.45399 | 63 |
| 27 | 0.45399 | 0.45658 | 0.45917 | 0.46175 | 0.46433 | 0.46690 | 0.46947 | 62 |
| 28 | 0.46947 | 0.47204 | 0.47460 | 0.47716 | 0.47971 | 0.48226 | 0.48481 | 61 |
| 29 | 0.48481 | 0.48735 | 0.48989 | 0.49242 | 0.49495 | 0.49748 | 0.50000 | 60 |
| 30 | 0.50000 | 0.50252 | 0.50503 | 0.50754 | 0.51004 | 0.51254 | 0.51504 | 59 |
| 31 | 0.51504 | 0.51753 | 0.52002 | 0.52250 | 0.52498 | 0.52745 | 0.52992 | 58 |
| 32 | 0.52992 | 0.53238 | 0.53484 | 0.53730 | 0.53975 | 0.54220 | 0.54464 | 57 |
| 33 | 0.54464 | 0.54708 | 0.54951 | 0.55194 | 0.55436 | 0.55678 | 0.55919 | 56 |
| 34 | 0.55919 | 0.56160 | 0.56401 | 0.56641 | 0.56880 | 0.57119 | 0.57358 | 55 |
| 35 | 0.57358 | 0.57596 | 0.57833 | 0.58070 | 0.58307 | 0.58543 | 0.58779 | 54 |
| 36 | 0.58779 | 0.59014 | 0.59248 | 0.59482 | 0.59716 | 0.59949 | 0.60182 | 53 |
| 37 | 0.60182 | 0.60414 | 0.60645 | 0.60876 | 0.61107 | 0.61337 | 0.61566 | 52 |
| 38 | 0.61566 | 0.61795 | 0.62024 | 0.62251 | 0.62479 | 0.62706 | 0.62932 | 51 |
| 39 | 0.62932 | 0.63158 | 0.63383 | 0.63608 | 0.63832 | 0.64056 | 0.64279 | 50 |
| 40 | 0.64279 | 0.64501 | 0.64723 | 0.64945 | 0.65166 | 0.65386 | 0.65606 | 49 |
| 41 | 0.65606 | 0.65825 | 0.66044 | 0.66262 | 0.66480 | 0.66697 | 0.66913 | 48 |
| 42 | 0.66913 | 0.67129 | 0.67344 | 0.67559 | 0.67773 | 0.67987 | 0.68200 | 47 |
| 43 | 0.68200 | 0.68412 | 0.68624 | 0.68835 | 0.69046 | 0.69256 | 0.69466 | 46 |
| 44 | 0.69466 | 0.69675 | 0.69883 | 0.70091 | 0.70298 | 0.70505 | 0.70711 | 45 |
| Sines | 60′ | 50′ | 40′ | 30′ Cosines | 20′ | 10′ | 0′ | Degrees |

# Natural Sines and Cosines

| Degrees | Cosines | | | | | | | Sines |
|---|---|---|---|---|---|---|---|---|
| | 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | |
| 0 | 1.00000 | 1.00000 | 0.99998 | 0.99996 | 0.99993 | 0.99989 | 0.99985 | 89 |
| 1 | 0.99985 | 0.99979 | 0.99973 | 0.99966 | 0.99958 | 0.99949 | 0.99939 | 88 |
| 2 | 0.99939 | 0.99929 | 0.99917 | 0.99905 | 0.99892 | 0.99878 | 0.99863 | 87 |
| 3 | 0.99863 | 0.99847 | 0.99831 | 0.99813 | 0.99795 | 0.99776 | 0.99756 | 86 |
| 4 | 0.99756 | 0.99736 | 0.99714 | 0.99692 | 0.99668 | 0.99644 | 0.99619 | 85 |
| 5 | 0.99619 | 0.99594 | 0.99567 | 0.99540 | 0.99511 | 0.99482 | 0.99452 | 84 |
| 6 | 0.99452 | 0.99421 | 0.99390 | 0.99357 | 0.99324 | 0.99290 | 0.99255 | 83 |
| 7 | 0.99255 | 0.99219 | 0.99182 | 0.99144 | 0.99106 | 0.99067 | 0.99027 | 82 |
| 8 | 0.99027 | 0.98986 | 0.98944 | 0.98902 | 0.98858 | 0.98814 | 0.98769 | 81 |
| 9 | 0.98769 | 0.98723 | 0.98676 | 0.98629 | 0.98580 | 0.98531 | 0.98481 | 80 |
| 10 | 0.98481 | 0.98430 | 0.98378 | 0.98325 | 0.98272 | 0.98218 | 0.98163 | 79 |
| 11 | 0.98163 | 0.98107 | 0.98050 | 0.97992 | 0.97934 | 0.97875 | 0.97815 | 78 |
| 12 | 0.97815 | 0.97754 | 0.97692 | 0.97630 | 0.97566 | 0.97502 | 0.97437 | 77 |
| 13 | 0.97437 | 0.97371 | 0.97304 | 0.97237 | 0.97169 | 0.97100 | 0.97030 | 76 |
| 14 | 0.97030 | 0.96959 | 0.96887 | 0.96815 | 0.96742 | 0.96667 | 0.96593 | 75 |
| 15 | 0.96593 | 0.96517 | 0.96440 | 0.96363 | 0.96285 | 0.96206 | 0.96126 | 74 |
| 16 | 0.96126 | 0.96046 | 0.95964 | 0.95882 | 0.95799 | 0.95715 | 0.95630 | 73 |
| 17 | 0.95630 | 0.95545 | 0.95459 | 0.95372 | 0.95284 | 0.95195 | 0.95106 | 72 |
| 18 | 0.95106 | 0.95015 | 0.94924 | 0.94832 | 0.94740 | 0.94646 | 0.94552 | 71 |
| 19 | 0.94552 | 0.94457 | 0.94361 | 0.94264 | 0.94167 | 0.94068 | 0.93969 | 70 |
| 20 | 0.93969 | 0.93869 | 0.93769 | 0.93667 | 0.93565 | 0.93462 | 0.93358 | 69 |
| 21 | 0.93358 | 0.93253 | 0.93148 | 0.93042 | 0.92935 | 0.92827 | 0.92718 | 68 |
| 22 | 0.92718 | 0.92609 | 0.92499 | 0.92388 | 0.92276 | 0.92164 | 0.92050 | 67 |
| 23 | 0.92050 | 0.91936 | 0.91822 | 0.91706 | 0.91590 | 0.91472 | 0.91355 | 66 |
| 24 | 0.91355 | 0.91236 | 0.91116 | 0.90996 | 0.90875 | 0.90753 | 0.90631 | 65 |
| 25 | 0.90631 | 0.90507 | 0.90383 | 0.90259 | 0.90133 | 0.90007 | 0.89879 | 64 |
| 26 | 0.89879 | 0.89752 | 0.89623 | 0.89493 | 0.89363 | 0.89232 | 0.89101 | 63 |
| 27 | 0.89101 | 0.88968 | 0.88835 | 0.88701 | 0.88566 | 0.88431 | 0.88295 | 62 |
| 28 | 0.88295 | 0.88158 | 0.88020 | 0.87882 | 0.87743 | 0.87603 | 0.87462 | 61 |
| 29 | 0.87462 | 0.87321 | 0.87178 | 0.87036 | 0.86892 | 0.86748 | 0.86603 | 60 |
| 30 | 0.86603 | 0.86457 | 0.86310 | 0.86163 | 0.86015 | 0.85866 | 0.85717 | 59 |
| 31 | 0.85717 | 0.85567 | 0.85416 | 0.85264 | 0.85112 | 0.84959 | 0.84805 | 58 |
| 32 | 0.84805 | 0.84650 | 0.84495 | 0.84339 | 0.84182 | 0.84025 | 0.83867 | 57 |
| 33 | 0.83867 | 0.83708 | 0.83549 | 0.83389 | 0.83228 | 0.83066 | 0.82904 | 56 |
| 34 | 0.82904 | 0.82741 | 0.82577 | 0.82413 | 0.82248 | 0.82082 | 0.81915 | 55 |
| 35 | 0.81915 | 0.81748 | 0.81580 | 0.81412 | 0.81242 | 0.81072 | 0.80902 | 54 |
| 36 | 0.80902 | 0.80730 | 0.80558 | 0.80386 | 0.80212 | 0.80038 | 0.79864 | 53 |
| 37 | 0.79864 | 0.79688 | 0.79512 | 0.79335 | 0.79158 | 0.78980 | 0.78801 | 52 |
| 38 | 0.78801 | 0.78622 | 0.78442 | 0.78261 | 0.78079 | 0.77897 | 0.77715 | 51 |
| 39 | 0.77715 | 0.77531 | 0.77347 | 0.77162 | 0.76977 | 0.76791 | 0.76604 | 50 |
| 40 | 0.76604 | 0.76417 | 0.76229 | 0.76041 | 0.75851 | 0.75661 | 0.75471 | 49 |
| 41 | 0.75471 | 0.75280 | 0.75088 | 0.74896 | 0.74703 | 0.74509 | 0.74314 | 48 |
| 42 | 0.74314 | 0.74120 | 0.73924 | 0.73728 | 0.73531 | 0.73333 | 0.73135 | 47 |
| 43 | 0.73135 | 0.72937 | 0.72737 | 0.72537 | 0.72337 | 0.72136 | 0.71934 | 46 |
| 44 | 0.71934 | 0.71732 | 0.71529 | 0.71325 | 0.71121 | 0.70916 | 0.70711 | 45 |
| Cosines | 60′ | 50′ | 40′ | 30′ | 20′ | 10′ | 0′ | Degrees |
| | Sines | | | | | | | |

# Natural Secants and Cosecants

| Degrees | Secants | | | | | | | Co-secants |
|---|---|---|---|---|---|---|---|---|
| | 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | |
| 0 | 1.00000 | 1.00000 | 1.00002 | 1.00004 | 1.00007 | 1.00011 | 1.00015 | 89 |
| 1 | 1.00015 | 1.00021 | 1.00027 | 1.00034 | 1.00042 | 1.00051 | 1.00061 | 88 |
| 2 | 1.00061 | 1.00072 | 1.00083 | 1.00095 | 1.00108 | 1.00122 | 1.00137 | 87 |
| 3 | 1.00137 | 1.00153 | 1.00169 | 1.00187 | 1.00205 | 1.00224 | 1.00244 | 86 |
| 4 | 1.00244 | 1.00265 | 1.00287 | 1.00309 | 1.00333 | 1.00357 | 1.00382 | 85 |
| 5 | 1.00382 | 1.00408 | 1.00435 | 1.00463 | 1.00491 | 1.00521 | 1.00551 | 84 |
| 6 | 1.00551 | 1.00582 | 1.00614 | 1.00647 | 1.00681 | 1.00715 | 1.00751 | 83 |
| 7 | 1.00751 | 1.00787 | 1.00825 | 1.00863 | 1.00902 | 1.00942 | 1.00983 | 82 |
| 8 | 1.00983 | 1.01024 | 1.01067 | 1.01111 | 1.01155 | 1.01200 | 1.01247 | 81 |
| 9 | 1.01247 | 1.01294 | 1.01342 | 1.01391 | 1.01440 | 1.01491 | 1.01543 | 80 |
| 10 | 1.01543 | 1.01595 | 1.01649 | 1.01703 | 1.01758 | 1.01815 | 1.01872 | 79 |
| 11 | 1.01872 | 1.01930 | 1.01989 | 1.02049 | 1.02110 | 1.02171 | 1.02234 | 78 |
| 12 | 1.02234 | 1.02298 | 1.02362 | 1.02428 | 1.02494 | 1.02562 | 1.02630 | 77 |
| 13 | 1.02630 | 1.02700 | 1.02770 | 1.02842 | 1.02914 | 1.02987 | 1.03061 | 76 |
| 14 | 1.03061 | 1.03137 | 1.03213 | 1.03290 | 1.03368 | 1.03447 | 1.03528 | 75 |
| 15 | 1.03528 | 1.03609 | 1.03691 | 1.03774 | 1.03858 | 1.03944 | 1.04030 | 74 |
| 16 | 1.04030 | 1.04117 | 1.04206 | 1.04295 | 1.04385 | 1.04477 | 1.04569 | 73 |
| 17 | 1.04569 | 1.04663 | 1.04757 | 1.04853 | 1.04950 | 1.05047 | 1.05146 | 72 |
| 18 | 1.05146 | 1.05246 | 1.05347 | 1.05449 | 1.05552 | 1.05657 | 1.05762 | 71 |
| 19 | 1.05762 | 1.05869 | 1.05976 | 1.06085 | 1.06195 | 1.06306 | 1.06418 | 70 |
| 20 | 1.06418 | 1.06531 | 1.06645 | 1.06761 | 1.06878 | 1.06995 | 1.07115 | 69 |
| 21 | 1.07115 | 1.07235 | 1.07356 | 1.07479 | 1.07602 | 1.07727 | 1.07853 | 68 |
| 22 | 1.07853 | 1.07981 | 1.08109 | 1.08239 | 1.08370 | 1.08503 | 1.08636 | 67 |
| 23 | 1.08636 | 1.08771 | 1.08907 | 1.09044 | 1.09183 | 1.09323 | 1.09464 | 66 |
| 24 | 1.09464 | 1.09606 | 1.09750 | 1.09895 | 1.10041 | 1.10189 | 1.10338 | 65 |
| 25 | 1.10338 | 1.10488 | 1.10640 | 1.10793 | 1.10947 | 1.11103 | 1.11260 | 64 |
| 26 | 1.11260 | 1.11419 | 1.11579 | 1.11740 | 1.11903 | 1.12067 | 1.12233 | 63 |
| 27 | 1.12233 | 1.12400 | 1.12568 | 1.12738 | 1.12910 | 1.13083 | 1.13257 | 62 |
| 28 | 1.13257 | 1.13433 | 1.13610 | 1.13789 | 1.13970 | 1.14152 | 1.14335 | 61 |
| 29 | 1.14335 | 1.14521 | 1.14707 | 1.14896 | 1.15085 | 1.15277 | 1.15470 | 60 |
| 30 | 1.15470 | 1.15665 | 1.15861 | 1.16059 | 1.16259 | 1.16460 | 1.16663 | 59 |
| 31 | 1.16663 | 1.16868 | 1.17075 | 1.17283 | 1.17493 | 1.17704 | 1.17918 | 58 |
| 32 | 1.17918 | 1.18133 | 1.18350 | 1.18569 | 1.18790 | 1.19012 | 1.19236 | 57 |
| 33 | 1.19236 | 1.19463 | 1.19691 | 1.19920 | 1.20152 | 1.20386 | 1.20622 | 56 |
| 34 | 1.20622 | 1.20859 | 1.21099 | 1.21341 | 1.21584 | 1.21830 | 1.22077 | 55 |
| 35 | 1.22077 | 1.22327 | 1.22579 | 1.22833 | 1.23089 | 1.23347 | 1.23607 | 54 |
| 36 | 1.23607 | 1.23869 | 1.24134 | 1.24400 | 1.24669 | 1.24940 | 1.25214 | 53 |
| 37 | 1.25214 | 1.25489 | 1.25767 | 1.26047 | 1.26330 | 1.26615 | 1.26902 | 52 |
| 38 | 1.26902 | 1.27191 | 1.27483 | 1.27778 | 1.28075 | 1.28374 | 1.28676 | 51 |
| 39 | 1.28676 | 1.28980 | 1.29287 | 1.29597 | 1.29909 | 1.30223 | 1.30541 | 50 |
| 40 | 1.30541 | 1.30861 | 1.31183 | 1.31509 | 1.31837 | 1.32168 | 1.32501 | 49 |
| 41 | 1.32501 | 1.32838 | 1.33177 | 1.33519 | 1.33864 | 1.34212 | 1.34563 | 48 |
| 42 | 1.34563 | 1.34917 | 1.35274 | 1.35634 | 1.35997 | 1.36363 | 1.36733 | 47 |
| 43 | 1.36733 | 1.37105 | 1.37481 | 1.37860 | 1.38242 | 1.38628 | 1.39016 | 46 |
| 44 | 1.39016 | 1.39409 | 1.39804 | 1.40203 | 1.40606 | 1.41012 | 1.41421 | 45 |
| Secants | 60′ | 50′ | 40′ | 30′ | 20′ | 10′ | 0′ | Degrees |
| | Cosecants | | | | | | | |

# Natural Secants and Cosecants

| Degrees | Cosecants | | | | | | | Secants |
|---|---|---|---|---|---|---|---|---|
| | 0′ | 10′ | 20′ | 30′ | 40′ | 50′ | 60′ | |
| 0 | ∝ | 343.77516 | 171.88831 | 114.59301 | 85.94561 | 68.75736 | 57.29869 | 89 |
| 1 | 57.29869 | 49.11406 | 42.97571 | 38.20155 | 34.38232 | 31.25758 | 28.65371 | 88 |
| 2 | 28.65371 | 26.45051 | 24.56212 | 22.92559 | 21.49368 | 20.23028 | 19.10732 | 87 |
| 3 | 19.10732 | 18.10262 | 17.19843 | 16.38041 | 15.63679 | 14.95788 | 14.33559 | 86 |
| 4 | 14.33559 | 13.76312 | 13.23472 | 12.74550 | 12.29125 | 11.86837 | 11.47371 | 85 |
| 5 | 11.47371 | 11.10455 | 10.75849 | 10.43343 | 10.12752 | 9.83912 | 9.56677 | 84 |
| 6 | 9.56677 | 9.30917 | 9.06515 | 8.83367 | 8.61379 | 8.40466 | 8.20551 | 83 |
| 7 | 8.20551 | 8.01565 | 7.83443 | 7.66130 | 7.49571 | 7.33719 | 7.18530 | 82 |
| 8 | 7.18530 | 7.03962 | 6.89979 | 6.76547 | 6.63633 | 6.51208 | 6.39245 | 81 |
| 9 | 6.39245 | 6.27719 | 6.16607 | 6.05886 | 5.95536 | 5.85539 | 5.75877 | 80 |
| 10 | 5.75877 | 5.66533 | 5.57493 | 5.48740 | 5.40263 | 5.32049 | 5.24084 | 79 |
| 11 | 5.24084 | 5.16359 | 5.08863 | 5.01585 | 4.94517 | 4.87649 | 4.80973 | 78 |
| 12 | 4.80973 | 4.74482 | 4.68167 | 4.62023 | 4.56041 | 4.50216 | 4.44541 | 77 |
| 13 | 4.44541 | 4.39012 | 4.33622 | 4.28366 | 4.23239 | 4.18238 | 4.13357 | 76 |
| 14 | 4.13357 | 4.08591 | 4.03938 | 3.99393 | 3.94952 | 3.90613 | 3.86370 | 75 |
| 15 | 3.86370 | 3.82223 | 3.78166 | 3.74198 | 3.70315 | 3.66515 | 3.62796 | 74 |
| 16 | 3.62796 | 3.59154 | 3.55587 | 3.52094 | 3.48671 | 3.45317 | 3.42030 | 73 |
| 17 | 3.42030 | 3.38808 | 3.35649 | 3.32551 | 3.29512 | 3.26531 | 3.23607 | 72 |
| 18 | 3.23607 | 3.20737 | 3.17920 | 3.15155 | 3.12440 | 3.09774 | 3.07155 | 71 |
| 19 | 3.07155 | 3.04584 | 3.02057 | 2.99574 | 2.97135 | 2.94737 | 2.92380 | 70 |
| 20 | 2.92380 | 2.90063 | 2.87785 | 2.85545 | 2.83342 | 2.81175 | 2.79043 | 69 |
| 21 | 2.79043 | 2.76945 | 2.74881 | 2.72850 | 2.70851 | 2.68884 | 2.66947 | 68 |
| 22 | 2.66947 | 2.65040 | 2.63162 | 2.61313 | 2.59491 | 2.57698 | 2.55930 | 67 |
| 23 | 2.55930 | 2.54190 | 2.52474 | 2.50784 | 2.49119 | 2.47477 | 2.45859 | 66 |
| 24 | 2.45859 | 2.44264 | 2.42692 | 2.41142 | 2.39614 | 2.38107 | 2.36620 | 65 |
| 25 | 2.36620 | 2.35154 | 2.33708 | 2.32282 | 2.30875 | 2.29487 | 2.28117 | 64 |
| 26 | 2.28117 | 2.26766 | 2.25432 | 2.24116 | 2.22817 | 2.21535 | 2.20269 | 63 |
| 27 | 2.20269 | 2.19019 | 2.17786 | 2.16568 | 2.15366 | 2.14178 | 2.13005 | 62 |
| 28 | 2.13005 | 2.11847 | 2.10704 | 2.09574 | 2.08458 | 2.07356 | 2.06267 | 61 |
| 29 | 2.06267 | 2.05191 | 2.04128 | 2.03077 | 2.02039 | 2.01014 | 2.00000 | 60 |
| 30 | 2.00000 | 1.98998 | 1.98008 | 1.97029 | 1.96062 | 1.95106 | 1.94160 | 59 |
| 31 | 1.94160 | 1.93226 | 1.92302 | 1.91388 | 1.90485 | 1.89591 | 1.88709 | 58 |
| 32 | 1.88708 | 1.87834 | 1.86970 | 1.86116 | 1.85271 | 1.84435 | 1.83608 | 57 |
| 33 | 1.83608 | 1.82790 | 1.81981 | 1.81180 | 1.80388 | 1.79604 | 1.78829 | 56 |
| 34 | 1.78829 | 1.78062 | 1.77303 | 1.76552 | 1.75808 | 1.75073 | 1.74345 | 55 |
| 35 | 1.74345 | 1.73624 | 1.72911 | 1.72205 | 1.71506 | 1.70815 | 1.70130 | 54 |
| 36 | 1.70130 | 1.69452 | 1.68782 | 1.68117 | 1.67460 | 1.66809 | 1.66164 | 53 |
| 37 | 1.66164 | 1.65526 | 1.64894 | 1.64268 | 1.63648 | 1.63035 | 1.62427 | 52 |
| 38 | 1.62427 | 1.61825 | 1.61229 | 1.60639 | 1.60054 | 1.59475 | 1.58902 | 51 |
| 39 | 1.58902 | 1.58333 | 1.57771 | 1.57213 | 1.56661 | 1.56114 | 1.55572 | 50 |
| 40 | 1.55572 | 1.55036 | 1.54504 | 1.53977 | 1.53455 | 1.52938 | 1.52425 | 49 |
| 41 | 1.52425 | 1.51918 | 1.51415 | 1.50916 | 1.50422 | 1.49933 | 1.49448 | 48 |
| 42 | 1.49448 | 1.48967 | 1.48491 | 1.48019 | 1.47551 | 1.47087 | 1.46628 | 47 |
| 43 | 1.46628 | 1.46173 | 1.45721 | 1.45274 | 1.44831 | 1.44391 | 1.43956 | 46 |
| 44 | 1.43956 | 1.43524 | 1.43096 | 1.42672 | 1.42251 | 1.41835 | 1.41421 | 45 |
| Co-secants | 60′ | 50′ | 40′ | 30′ | 20′ | 10′ | 0′ | Degrees |
| | Secants | | | | | | | |

# Functions of Numbers, 1 to 49

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter Circum. | Area |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1.0000 | 1.0000 | 0.00000 | 1000.000 | 3.142 | 0.7854 |
| 2 | 4 | 8 | 1.4142 | 1.2599 | 0.30103 | 500.000 | 6.283 | 3.1416 |
| 3 | 9 | 27 | 1.7321 | 1.4422 | 0.47712 | 333.333 | 9.425 | 7.0686 |
| 4 | 16 | 64 | 2.0000 | 1.5874 | 0.60206 | 250.000 | 12.566 | 12.5664 |
| 5 | 25 | 125 | 2.2361 | 1.7100 | 0.69897 | 200.000 | 15.708 | 19.6350 |
| 6 | 36 | 216 | 2.4495 | 1.8171 | 0.77815 | 166.667 | 18.850 | 28.2743 |
| 7 | 49 | 343 | 2.6458 | 1.9129 | 0.84510 | 142.857 | 21.991 | 38.4845 |
| 8 | 64 | 512 | 2.8284 | 2.0000 | 0.90309 | 125.000 | 25.133 | 50.2655 |
| 9 | 81 | 729 | 3.0000 | 2.0801 | 0.95424 | 111.111 | 28.274 | 63.6173 |
| 10 | 100 | 1000 | 3.1623 | 2.1544 | 1.00000 | 100.000 | 31.416 | 78.5398 |
| 11 | 121 | 1331 | 3.3166 | 2.2240 | 1.04139 | 90.9091 | 34.558 | 95.0332 |
| 12 | 144 | 1728 | 3.4641 | 2.2894 | 1.07918 | 83.3333 | 37.699 | 113.097 |
| 13 | 169 | 2197 | 3.6056 | 2.3513 | 1.11394 | 76.9231 | 40.841 | 132.732 |
| 14 | 196 | 2744 | 3.7417 | 2.4101 | 1.14613 | 71.4286 | 43.982 | 153.938 |
| 15 | 225 | 3375 | 3.8730 | 2.4662 | 1.17609 | 66.6667 | 47.124 | 176.715 |
| 16 | 256 | 4096 | 4.0000 | 2.5198 | 1.20412 | 62.5000 | 50.265 | 201.062 |
| 17 | 289 | 4913 | 4.1231 | 2.5713 | 1.23045 | 58.8235 | 53.407 | 226.980 |
| 18 | 324 | 5832 | 4.2426 | 2.6207 | 1.25527 | 55.5556 | 56.549 | 254.469 |
| 19 | 361 | 6859 | 4.3589 | 2.6684 | 1.27875 | 52.6316 | 59.690 | 283.529 |
| 20 | 400 | 8000 | 4.4721 | 2.7144 | 1.30103 | 50.0000 | 62.832 | 314.159 |
| 21 | 441 | 9261 | 4.5826 | 2.7589 | 1.32222 | 47.6190 | 65.973 | 346.361 |
| 22 | 484 | 10648 | 4.6904 | 2.8020 | 1.34242 | 45.4545 | 69.115 | 380.133 |
| 23 | 529 | 12167 | 4.7958 | 2.8439 | 1.36173 | 43.4783 | 72.257 | 415.476 |
| 24 | 576 | 13824 | 4.8990 | 2.8845 | 1.38021 | 41.6667 | 75.398 | 452.389 |
| 25 | 625 | 15625 | 5.0000 | 2.9240 | 1.39794 | 40.0000 | 78.540 | 490.874 |
| 26 | 676 | 17576 | 5.0990 | 2.9625 | 1.41497 | 38.4615 | 81.681 | 530.929 |
| 27 | 729 | 19683 | 5.1962 | 3.0000 | 1.43136 | 37.0370 | 84.823 | 572.555 |
| 28 | 784 | 21952 | 5.2915 | 3.0366 | 1.44716 | 35.7143 | 87.965 | 615.752 |
| 29 | 841 | 24389 | 5.3852 | 3.0723 | 1.46240 | 34.4828 | 91.106 | 660.520 |
| 30 | 900 | 27000 | 5.4772 | 3.1072 | 1.47712 | 33.3333 | 94.248 | 706.858 |
| 31 | 961 | 29791 | 5.5678 | 3.1414 | 1.49136 | 32.2581 | 97.389 | 754.768 |
| 32 | 1024 | 32768 | 5.6569 | 3.1748 | 1.50515 | 31.2500 | 100.531 | 804.248 |
| 33 | 1089 | 35937 | 5.7446 | 3.2075 | 1.51851 | 30.3030 | 103.673 | 855.299 |
| 34 | 1156 | 39304 | 5.8310 | 3.2396 | 1.53148 | 29.4118 | 106.814 | 907.920 |
| 35 | 1225 | 42875 | 5.9161 | 3.2711 | 1.54407 | 28.5714 | 109.956 | 962.113 |
| 36 | 1296 | 46656 | 6.0000 | 3.3019 | 1.55630 | 27.7778 | 113.097 | 1017.88 |
| 37 | 1369 | 50653 | 6.0828 | 3.3322 | 1.56820 | 27.0270 | 116.239 | 1075.21 |
| 38 | 1444 | 54872 | 6.1644 | 3.3620 | 1.57978 | 26.3158 | 119.381 | 1134.11 |
| 39 | 1521 | 59319 | 6.2450 | 3.3912 | 1.59106 | 25.6410 | 122.522 | 1194.59 |
| 40 | 1600 | 64000 | 6.3246 | 3.4200 | 1.60206 | 25.0000 | 125.66 | 1256.64 |
| 41 | 1681 | 68921 | 6.4031 | 3.4482 | 1.61278 | 24.3902 | 128.81 | 1320.25 |
| 42 | 1764 | 74088 | 6.4807 | 3.4760 | 1.62325 | 23.8095 | 131.95 | 1385.44 |
| 43 | 1849 | 79507 | 6.5574 | 3.5034 | 1.63347 | 23.2558 | 135.09 | 1452.20 |
| 44 | 1936 | 85184 | 6.6332 | 3.5303 | 1.64345 | 22.7273 | 138.23 | 1520.53 |
| 45 | 2025 | 91125 | 6.7082 | 3.5569 | 1.65321 | 22.2222 | 141.37 | 1590.43 |
| 46 | 2116 | 97336 | 6.7823 | 3.5830 | 1.66276 | 21.7391 | 144.51 | 1661.90 |
| 47 | 2209 | 103823 | 6.8557 | 3.6088 | 1.67210 | 21.2766 | 147.65 | 1734.94 |
| 48 | 2304 | 110592 | 6.9282 | 3.6342 | 1.68124 | 20.8333 | 150.80 | 1809.56 |
| 49 | 2401 | 117649 | 7.0000 | 3.6593 | 1.69020 | 20.4082 | 153.94 | 1885.74 |

# Functions of Numbers, 50 to 99

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 50 | 2500 | 125000 | 7.0711 | 3.6840 | 1.69897 | 20.0000 | 157.08 | 1963.50 |
| 51 | 2601 | 132651 | 7.1414 | 3.7084 | 1.70757 | 19.6078 | 160.22 | 2042.82 |
| 52 | 2704 | 140608 | 7.2111 | 3.7325 | 1.71600 | 19.2308 | 163.36 | 2123.72 |
| 53 | 2809 | 148877 | 7.2801 | 3.7563 | 1.72428 | 18.8679 | 166.50 | 2206.18 |
| 54 | 2916 | 157464 | 7.3485 | 3.7798 | 1.73239 | 18.5185 | 169.65 | 2290.22 |
| 55 | 3025 | 166375 | 7.4162 | 3.8030 | 1.74036 | 18.1818 | 172.79 | 2375.83 |
| 56 | 3136 | 175616 | 7.4833 | 3.8259 | 1.74819 | 17.8571 | 175.93 | 2463.01 |
| 57 | 3249 | 185193 | 7.5498 | 3.8485 | 1.75587 | 17.5439 | 179.07 | 2551.76 |
| 58 | 3364 | 195112 | 7.6158 | 3.8709 | 1.76343 | 17.2414 | 182.21 | 2642.08 |
| 59 | 3481 | 205379 | 7.6811 | 3.8930 | 1.77085 | 16.9492 | 185.35 | 2733.97 |
| 60 | 3600 | 216000 | 7.7460 | 3.9149 | 1.77815 | 16.6667 | 188.50 | 2827.43 |
| 61 | 3721 | 226981 | 7.8102 | 3.9365 | 1.78533 | 16.3934 | 191.64 | 2922.47 |
| 62 | 3844 | 238328 | 7.8740 | 3.9579 | 1.79239 | 16.1290 | 194.78 | 3019.07 |
| 63 | 3969 | 250047 | 7.9373 | 3.9791 | 1.79934 | 15.8730 | 197.92 | 3117.25 |
| 64 | 4096 | 262144 | 8.0000 | 4.0000 | 1.80618 | 15.6250 | 201.06 | 3216.99 |
| 65 | 4225 | 274625 | 8.0623 | 4.0207 | 1.81291 | 15.3846 | 204.20 | 3318.31 |
| 66 | 4356 | 287496 | 8.1240 | 4.0412 | 1.81954 | 15.1515 | 207.35 | 3421.19 |
| 67 | 4489 | 300763 | 8.1854 | 4.0615 | 1.82607 | 14.9254 | 210.49 | 3525.65 |
| 68 | 4624 | 314432 | 8.2462 | 4.0817 | 1.83251 | 14.7059 | 213.63 | 3631.68 |
| 69 | 4761 | 328509 | 8.3066 | 4.1016 | 1.83885 | 14.4928 | 216.77 | 3739.28 |
| 70 | 4900 | 343000 | 8.3666 | 4.1213 | 1.84510 | 14.2857 | 219.91 | 3848.45 |
| 71 | 5041 | 357911 | 8.4261 | 4.1408 | 1.85126 | 14.0845 | 223.05 | 3959.19 |
| 72 | 5184 | 373248 | 8.4853 | 4.1602 | 1.85733 | 13.8889 | 226.19 | 4071.50 |
| 73 | 5329 | 389017 | 8.5440 | 4.1793 | 1.86332 | 13.6986 | 229.34 | 4185.39 |
| 74 | 5476 | 405224 | 8.6023 | 4.1983 | 1.86923 | 13.5135 | 232.48 | 4300.84 |
| 75 | 5625 | 421875 | 8.6603 | 4.2172 | 1.87506 | 13.3333 | 235.62 | 4417.86 |
| 76 | 5776 | 438976 | 8.7178 | 4.2358 | 1.88081 | 13.1579 | 238.76 | 4536.46 |
| 77 | 5929 | 456533 | 8.7750 | 4.2543 | 1.88649 | 12.9870 | 241.90 | 4656.63 |
| 78 | 6084 | 474552 | 8.8318 | 4.2727 | 1.89209 | 12.8205 | 245.04 | 4778.36 |
| 79 | 6241 | 493039 | 8.8882 | 4.2908 | 1.89763 | 12.6582 | 248.19 | 4901.67 |
| 80 | 6400 | 512000 | 8.9443 | 4.3089 | 1.90309 | 12.5000 | 251.33 | 5026.55 |
| 81 | 6561 | 531441 | 9.0000 | 4.3267 | 1.90849 | 12.3457 | 254.47 | 5153.00 |
| 82 | 6724 | 551368 | 9.0554 | 4.3445 | 1.91381 | 12.1951 | 257.61 | 5281.02 |
| 83 | 6889 | 571787 | 9.1104 | 4.3621 | 1.91908 | 12.0482 | 260.75 | 5410.61 |
| 84 | 7056 | 592704 | 9.1652 | 4.3795 | 1.92428 | 11.9048 | 263.89 | 5541.77 |
| 85 | 7225 | 614125 | 9.2195 | 4.3968 | 1.92942 | 11.7647 | 267.04 | 5674.50 |
| 86 | 7396 | 636056 | 9.2736 | 4.4140 | 1.93450 | 11.6279 | 270.18 | 5808.80 |
| 87 | 7569 | 658503 | 9.3274 | 4.4310 | 1.93952 | 11.4943 | 273.32 | 5944.68 |
| 88 | 7744 | 681472 | 9.3808 | 4.4480 | 1.94448 | 11.3636 | 276.46 | 6082.12 |
| 89 | 7921 | 704969 | 9.4340 | 4.4647 | 1.94939 | 11.2360 | 279.60 | 6221.14 |
| 90 | 8100 | 729000 | 9.4868 | 4.4814 | 1.95424 | 11.1111 | 282.74 | 6361.73 |
| 91 | 8281 | 753571 | 9.5394 | 4.4979 | 1.95904 | 10.9890 | 285.88 | 6503.88 |
| 92 | 8464 | 778688 | 9.5917 | 4.5144 | 1.96379 | 10.8696 | 289.03 | 6647.61 |
| 93 | 8649 | 804357 | 9.6437 | 4.5307 | 1.96848 | 10.7527 | 292.17 | 6792.91 |
| 94 | 8836 | 830584 | 9.6954 | 4.5468 | 1.97313 | 10.6383 | 295.31 | 6939.78 |
| 95 | 9025 | 857375 | 9.7468 | 4.5629 | 1.97772 | 10.5263 | 298.45 | 7088.22 |
| 96 | 9216 | 884736 | 9.7980 | 4.5789 | 1.98227 | 10.4167 | 301.59 | 7238.23 |
| 97 | 9409 | 912673 | 9.8489 | 4.5947 | 1.98677 | 10.3093 | 304.73 | 7389.81 |
| 98 | 9604 | 941192 | 9.8995 | 4.6104 | 1.99123 | 10.2041 | 307.88 | 7542.96 |
| 99 | 9801 | 970299 | 9.9499 | 4.6261 | 1.99564 | 10.1010 | [illegible] | [illegible].69 |

# Functions of Numbers, 100 to 149

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 100 | 10000 | 1000000 | 10.0000 | 4.6416 | 2.00000 | 10.0000 | 314.16 | 7853.98 |
| 101 | 10201 | 1030301 | 10.0499 | 4.6570 | 2.00432 | 9.90099 | 317.30 | 8011.85 |
| 102 | 10404 | 1061208 | 10.0995 | 4.6723 | 2.00860 | 9.80392 | 320.44 | 8171.28 |
| 103 | 10609 | 1092727 | 10.1489 | 4.6875 | 2.01284 | 9.70874 | 323.58 | 8332.29 |
| 104 | 10816 | 1124864 | 10.1980 | 4.7027 | 2.01703 | 9.61538 | 326.73 | 8494.87 |
| 105 | 11025 | 1157625 | 10.2470 | 4.7177 | 2.02119 | 9.52381 | 329.87 | 8659.01 |
| 106 | 11236 | 1191016 | 10.2956 | 4.7326 | 2.02531 | 9.43396 | 333.01 | 8824.73 |
| 107 | 11449 | 1225043 | 10.3441 | 4.7475 | 2.02938 | 9.34579 | 336.15 | 8992.02 |
| 108 | 11664 | 1259712 | 10.3923 | 4.7622 | 2.03342 | 9.25926 | 339.29 | 9160.88 |
| 109 | 11881 | 1295029 | 10.4403 | 4.7769 | 2.03743 | 9.17431 | 342.43 | 9331.32 |
| 110 | 12100 | 1331000 | 10.4881 | 4.7914 | 2.04139 | 9.09091 | 345.58 | 9503.32 |
| 111 | 12321 | 1367631 | 10.5357 | 4.8059 | 2.04532 | 9.00901 | 348.72 | 9676.89 |
| 112 | 12544 | 1404928 | 10.5830 | 4.8203 | 2.04922 | 8.92857 | 351.86 | 9852.03 |
| 113 | 12769 | 1442897 | 10.6301 | 4.8346 | 2.05308 | 8.84956 | 355.00 | 10028.7 |
| 114 | 12996 | 1481544 | 10.6771 | 4.8488 | 2.05690 | 8.77193 | 358.14 | 10207.0 |
| 115 | 13225 | 1520875 | 10.7238 | 4.8629 | 2.06070 | 8.69565 | 361.28 | 10386.9 |
| 116 | 13456 | 1560896 | 10.7703 | 4.8770 | 2.06446 | 8.62069 | 364.42 | 10568.3 |
| 117 | 13689 | 1601613 | 10.8167 | 4.8910 | 2.06819 | 8.54701 | 367.57 | 10751.3 |
| 118 | 13924 | 1643032 | 10.8628 | 4.9049 | 2.07188 | 8.47458 | 370.71 | 10935.9 |
| 119 | 14161 | 1685159 | 10.9087 | 4.9187 | 2.07555 | 8.40336 | 373.85 | 11122.0 |
| 120 | 14400 | 1728000 | 10.9545 | 4.9324 | 2.07918 | 8.33333 | 376.99 | 11309.7 |
| 121 | 14641 | 1771561 | 11.0000 | 4.9461 | 2.08279 | 8.26446 | 380.13 | 11499.0 |
| 122 | 14884 | 1815848 | 11.0454 | 4.9597 | 2.08636 | 8.19672 | 383.27 | 11689.9 |
| 123 | 15129 | 1860867 | 11.0905 | 4.9732 | 2.08991 | 8.13008 | 386.42 | 11882.3 |
| 124 | 15376 | 1906624 | 11.1355 | 4.9866 | 2.09342 | 8.06452 | 389.56 | 12076.3 |
| 125 | 15625 | 1953125 | 11.1803 | 5.0000 | 2.09691 | 8.00000 | 392.70 | 12271.8 |
| 126 | 15876 | 2000376 | 11.2250 | 5.0133 | 2.10037 | 7.93651 | 395.84 | 12469.0 |
| 127 | 16129 | 2048383 | 11.2694 | 5.0265 | 2.10380 | 7.87402 | 398.98 | 12667.7 |
| 128 | 16384 | 2097152 | 11.3137 | 5.0397 | 2.10721 | 7.81250 | 402.12 | 12868.0 |
| 129 | 16641 | 2146689 | 11.3578 | 5.0528 | 2.11059 | 7.75194 | 405.27 | 13069.8 |
| 130 | 16900 | 2197000 | 11.4018 | 5.0658 | 2.11394 | 7.69231 | 408.41 | 13273.2 |
| 131 | 17161 | 2248091 | 11.4455 | 5.0788 | 2.11727 | 7.63359 | 411.55 | 13478.2 |
| 132 | 17424 | 2299968 | 11.4891 | 5.0916 | 2.12057 | 7.57576 | 414.69 | 13684.8 |
| 133 | 17689 | 2352637 | 11.5326 | 5.1045 | 2.12385 | 7.51880 | 417.83 | 13892.9 |
| 134 | 17956 | 2406104 | 11.5758 | 5.1172 | 2.12710 | 7.46269 | 420.97 | 14102.6 |
| 135 | 18225 | 2460375 | 11.6190 | 5.1299 | 2.13033 | 7.40741 | 424.12 | 14313.9 |
| 136 | 18496 | 2515456 | 11.6619 | 5.1426 | 2.13354 | 7.35294 | 427.26 | 14526.7 |
| 137 | 18769 | 2571353 | 11.7047 | 5.1551 | 2.13672 | 7.29927 | 430.40 | 14741.1 |
| 138 | 19044 | 2628072 | 11.7473 | 5.1676 | 2.13988 | 7.24638 | 433.54 | 14957.1 |
| 139 | 19321 | 2685619 | 11.7898 | 5.1801 | 2.14301 | 7.19424 | 436.68 | 15174.7 |
| 140 | 19600 | 2744000 | 11.8322 | 5.1925 | 2.14613 | 7.14286 | 439.82 | 15393.8 |
| 141 | 19881 | 2803221 | 11.8743 | 5.2048 | 2.14922 | 7.09220 | 442.96 | 15614.5 |
| 142 | 20164 | 2863288 | 11.9164 | 5.2171 | 2.15229 | 7.04225 | 446.11 | 15836.8 |
| 143 | 20449 | 2924207 | 11.9583 | 5.2293 | 2.15534 | 6.99301 | 449.25 | 16060.6 |
| 144 | 20736 | 2985984 | 12.0000 | 5.2415 | 2.15836 | 6.94444 | 452.39 | 16286.0 |
| 145 | 21025 | 3048625 | 12.0416 | 5.2536 | 2.16137 | 6.89655 | 455.53 | 16513.0 |
| 146 | 21316 | 3112136 | 12.0830 | 5.2656 | 2.16435 | 6.84932 | 458.67 | 16741.5 |
| 147 | 21609 | 3176523 | 12.1244 | 5.2776 | 2.16732 | 6.80272 | 461.81 | 16971.7 |
| 148 | 21904 | 3241792 | 12.1655 | 5.2896 | 2.17026 | 6.75676 | 464.96 | 17203.4 |
| *149* | *22201* | 3307949 | 12.2066 | 5.3015 | 2.17319 | 6.71141 | 468.10 | 17436.6 |

# Functions of Numbers, 150 to 199

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter Circum. | No.=Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 150 | 22500 | 3375000 | 12.2474 | 5.3133 | 2.17609 | 6.66667 | 471.24 | 17671.5 |
| 151 | 22801 | 3442951 | 12.2882 | 5.3251 | 2.17898 | 6.62252 | 474.38 | 17907.9 |
| 152 | 23104 | 3511808 | 12.3288 | 5.3368 | 2.18184 | 6.57895 | 477.52 | 18145.8 |
| 153 | 23409 | 3581577 | 12.3693 | 5.3485 | 2.18469 | 6.53595 | 480.66 | 18385.4 |
| 154 | 23716 | 3652264 | 12.4097 | 5.3601 | 2.18752 | 6.49351 | 483.81 | 18626.5 |
| 155 | 24025 | 3723875 | 12.4499 | 5.3717 | 2.19033 | 6.45161 | 486.95 | 18869.2 |
| 156 | 24336 | 3796416 | 12.4900 | 5.3832 | 2.19312 | 6.41026 | 490.09 | 19113.4 |
| 157 | 24649 | 3869893 | 12.5300 | 5.3947 | 2.19590 | 6.36943 | 493.23 | 19359.3 |
| 158 | 24964 | 3944312 | 12.5698 | 5.4061 | 2.19866 | 6.32911 | 496.37 | 19606.7 |
| 159 | 25281 | 4019679 | 12.6095 | 5.4175 | 2.20140 | 6.28931 | 499.51 | 19855.7 |
| 160 | 25600 | 4096000 | 12.6491 | 5.4288 | 2.20412 | 6.25000 | 502.65 | 20106.2 |
| 161 | 25921 | 4173281 | 12.6886 | 5.4401 | 2.20683 | 6.21118 | 505.80 | 20358.3 |
| 162 | 26244 | 4251528 | 12.7279 | 5.4514 | 2.20952 | 6.17284 | 508.94 | 20612.0 |
| 163 | 26569 | 4330747 | 12.7671 | 5.4626 | 2.21219 | 6.13497 | 512.08 | 20867.2 |
| 164 | 26896 | 4410944 | 12.8062 | 5.4737 | 2.21484 | 6.09756 | 515.22 | 21124.1 |
| 165 | 27225 | 4492125 | 12.8452 | 5.4848 | 2.21748 | 6.06061 | 518.36 | 21382.5 |
| 166 | 27556 | 4574296 | 12.8841 | 5.4959 | 2.22011 | 6.02410 | 521.50 | 21642.4 |
| 167 | 27889 | 4657463 | 12.9228 | 5.5069 | 2.22272 | 5.98802 | 524.65 | 21904.0 |
| 168 | 28224 | 4741632 | 12.9615 | 5.5178 | 2.22531 | 5.95238 | 527.79 | 22167.1 |
| 169 | 28561 | 4826809 | 13.0000 | 5.5288 | 2.22789 | 5.91716 | 530.93 | 22431.8 |
| 170 | 28900 | 4913000 | 13.0384 | 5.5397 | 2.23045 | 5.88235 | 534.07 | 22698.0 |
| 171 | 29241 | 5000211 | 13.0767 | 5.5505 | 2.23300 | 5.84795 | 537.21 | 22965.8 |
| 172 | 29584 | 5088448 | 13.1149 | 5.5613 | 2.23553 | 5.81395 | 540.35 | 23235.2 |
| 173 | 29929 | 5177717 | 13.1529 | 5.5721 | 2.23805 | 5.78035 | 543.50 | 23506.2 |
| 174 | 30276 | 5268024 | 13.1909 | 5.5828 | 2.24055 | 5.74713 | 546.64 | 23778.7 |
| 175 | 30625 | 5359375 | 13.2288 | 5.5934 | 2.24304 | 5.71429 | 549.78 | 24052.8 |
| 176 | 30976 | 5451776 | 13.2665 | 5.6041 | 2.24551 | 5.68182 | 552.92 | 24328.5 |
| 177 | 31329 | 5545233 | 13.3041 | 5.6147 | 2.24797 | 5.64972 | 556.06 | 24605.7 |
| 178 | 31684 | 5639752 | 13.3417 | 5.6252 | 2.25042 | 5.61798 | 559.20 | 24884.6 |
| 179 | 32041 | 5735339 | 13.3791 | 5.6357 | 2.25285 | 5.58659 | 562.35 | 25164.9 |
| 180 | 32400 | 5832000 | 13.4164 | 5.6462 | 2.25527 | 5.55556 | 565.49 | 25446.9 |
| 181 | 32761 | 5929741 | 13.4536 | 5.6567 | 2.25768 | 5.52486 | 568.63 | 25730.4 |
| 182 | 33124 | 6028568 | 13.4907 | 5.6671 | 2.26007 | 5.49451 | 571.77 | 26015.5 |
| 183 | 33489 | 6128487 | 13.5277 | 5.6774 | 2.26245 | 5.46448 | 574.91 | 26302.2 |
| 184 | 33856 | 6229504 | 13.5647 | 5.6877 | 2.26482 | 5.43478 | 578.05 | 26590.4 |
| 185 | 34225 | 6331625 | 13.6015 | 5.6980 | 2.26717 | 5.40541 | 581.19 | 26880.3 |
| 186 | 34596 | 6434856 | 13.6382 | 5.7083 | 2.26951 | 5.37634 | 584.34 | 27171.6 |
| 187 | 34969 | 6539203 | 13.6748 | 5.7185 | 2.27184 | 5.34759 | 587.48 | 27464.6 |
| 188 | 35344 | 6644672 | 13.7113 | 5.7287 | 2.27416 | 5.31915 | 590.62 | 27759.1 |
| 189 | 35721 | 6751269 | 13.7477 | 5.7388 | 2.27646 | 5.29101 | 593.76 | 28055.2 |
| 190 | 36100 | 6859000 | 13.7840 | 5.7489 | 2.27875 | 5.26316 | 596.90 | 28352.9 |
| 191 | 36481 | 6967871 | 13.8203 | 5.7590 | 2.28103 | 5.23560 | 600.04 | 28652.1 |
| 192 | 36864 | 7077888 | 13.8564 | 5.7690 | 2.28330 | 5.20833 | 603.19 | 28952.9 |
| 193 | 37249 | 7189057 | 13.8924 | 5.7790 | 2.28556 | 5.18135 | 606.33 | 29255.3 |
| 194 | 37636 | 7301384 | 13.9284 | 5.7890 | 2.28780 | 5.15464 | 609.47 | 29559.2 |
| 195 | 38025 | 7414875 | 13.9642 | 5.7989 | 2.29003 | 5.12821 | 612.61 | 29864.8 |
| 196 | 38416 | 7529536 | 14.0000 | 5.8088 | 2.29226 | 5.10204 | 615.75 | 30171.9 |
| 197 | 38809 | 7645373 | 14.0357 | 5.8186 | 2.29447 | 5.07614 | 618.89 | 30480.5 |
| 198 | 39204 | 7762392 | 14.0712 | 5.8285 | 2.29667 | 5.05051 | 622.04 | 30790.7 |
| 199 | 39601 | 7880599 | 14.1067 | 5.8383 | 2.29885 | 5.02513 | 625.18 | 31102.6 |

# Functions of Numbers, 250 to 299

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter Circum. | No.=Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 250 | 62500 | 15625000 | 15.8114 | 6.2996 | 2.39794 | 4.00000 | 785.40 | 49087.4 |
| 251 | 63001 | 15813251 | 15.8430 | 6.3080 | 2.39967 | 3.98406 | 788.54 | 49480.9 |
| 252 | 63504 | 16003008 | 15.8745 | 6.3164 | 2.40140 | 3.96825 | 791.68 | 49875.9 |
| 253 | 64009 | 16194277 | 15.9060 | 6.3247 | 2.40312 | 3.95257 | 794.82 | 50272.6 |
| 254 | 64516 | 16387064 | 15.9374 | 6.3330 | 2.40483 | 3.93701 | 797.96 | 50670.7 |
| 255 | 65025 | 16581375 | 15.9687 | 6.3413 | 2.40654 | 3.92157 | 801.11 | 51070.5 |
| 256 | 65536 | 16777216 | 16.0000 | 6.3496 | 2.40824 | 3.90625 | 804.25 | 51471.9 |
| 257 | 66049 | 16974593 | 16.0312 | 6.3579 | 2.40993 | 3.89105 | 807.39 | 51874.8 |
| 258 | 66564 | 17173512 | 16.0624 | 6.3661 | 2.41162 | 3.87597 | 810.53 | 52279.2 |
| 259 | 67081 | 17373979 | 16.0935 | 6.3743 | 2.41330 | 3.86100 | 813.67 | 52685.3 |
| 260 | 67600 | 17576000 | 16.1245 | 6.3825 | 2.41497 | 3.84615 | 816.81 | 53092.9 |
| 261 | 68121 | 17779581 | 16.1555 | 6.3907 | 2.41664 | 3.83142 | 819.96 | 53502.1 |
| 262 | 68644 | 17984728 | 16.1864 | 6.3988 | 2.41830 | 3.81679 | 823.10 | 53912.9 |
| 263 | 69169 | 18191447 | 16.2173 | 6.4070 | 2.41996 | 3.80228 | 826.24 | 54325.2 |
| 264 | 69696 | 18399744 | 16.2481 | 6.4151 | 2.42160 | 3.78788 | 829.38 | 54739.1 |
| 265 | 70225 | 18609625 | 16.2788 | 6.4232 | 2.42325 | 3.77358 | 832.52 | 55154.6 |
| 266 | 70756 | 18821096 | 16.3095 | 6.4312 | 2.42488 | 3.75940 | 835.66 | 55571.6 |
| 267 | 71289 | 19034163 | 16.3401 | 6.4393 | 2.42651 | 3.74532 | 838.81 | 55990.2 |
| 268 | 71824 | 19248832 | 16.3707 | 6.4473 | 2.42813 | 3.73134 | 841.95 | 56410.4 |
| 269 | 72361 | 19465109 | 16.4012 | 6.4553 | 2.42975 | 3.71747 | 845.09 | 56832.2 |
| 270 | 72900 | 19683000 | 16.4317 | 6.4633 | 2.43136 | 3.70370 | 848.23 | 57255.5 |
| 271 | 73441 | 19902511 | 16.4621 | 6.4713 | 2.43297 | 3.69004 | 851.37 | 57680.4 |
| 272 | 73984 | 20123648 | 16.4924 | 6.4792 | 2.43457 | 3.67647 | 854.51 | 58106.9 |
| 273 | 74529 | 20346417 | 16.5227 | 6.4872 | 2.43616 | 3.66300 | 857.65 | 58534.9 |
| 274 | 75076 | 20570824 | 16.5529 | 6.4951 | 2.43775 | 3.64964 | 860.80 | 58964.6 |
| 275 | 75625 | 20796875 | 16.5831 | 6.5030 | 2.43933 | 3.63636 | 863.94 | 59395.7 |
| 276 | 76176 | 21024576 | 16.6132 | 6.5108 | 2.44091 | 3.62319 | 867.08 | 59828.5 |
| 277 | 76729 | 21253933 | 16.6433 | 6.5187 | 2.44248 | 3.61011 | 870.22 | 60262.8 |
| 278 | 77284 | 21484952 | 16.6733 | 6.5265 | 2.44404 | 3.59712 | 873.36 | 60698.7 |
| 279 | 77841 | 21717639 | 16.7033 | 6.5343 | 2.44560 | 3.58423 | 876.50 | 61136.2 |
| 280 | 78400 | 21952000 | 16.7332 | 6.5421 | 2.44716 | 3.57143 | 879.65 | 61575.2 |
| 281 | 78961 | 22188041 | 16.7631 | 6.5499 | 2.44871 | 3.55872 | 882.79 | 62015.8 |
| 282 | 79524 | 22425768 | 16.7929 | 6.5577 | 2.45025 | 3.54610 | 885.93 | 62458.0 |
| 283 | 80089 | 22665187 | 16.8226 | 6.5654 | 2.45179 | 3.53357 | 889.07 | 62901.8 |
| 284 | 80656 | 22906304 | 16.8523 | 6.5731 | 2.45332 | 3.52113 | 892.21 | 63347.1 |
| 285 | 81225 | 23149125 | 16.8819 | 6.5808 | 2.45484 | 3.50877 | 895.35 | 63794.0 |
| 286 | 81796 | 23393656 | 16.9115 | 6.5885 | 2.45637 | 3.49650 | 898.50 | 64242.4 |
| 287 | 82369 | 23639903 | 16.9411 | 6.5962 | 2.45788 | 3.48432 | 901.64 | 64692.5 |
| 288 | 82944 | 23887872 | 16.9706 | 6.6039 | 2.45939 | 3.47222 | 904.78 | 65144.1 |
| 289 | 83521 | 24137569 | 17.0000 | 6.6115 | 2.46090 | 3.46021 | 907.92 | 65597.2 |
| 290 | 84100 | 24389000 | 17.0294 | 6.6191 | 2.46240 | 3.44828 | 911.06 | 66052.0 |
| 291 | 84681 | 24642171 | 17.0587 | 6.6267 | 2.46389 | 3.43643 | 914.20 | 66508.3 |
| 292 | 85264 | 24897088 | 17.0880 | 6.6343 | 2.46538 | 3.42466 | 917.35 | 66966.2 |
| 293 | 85849 | 25153757 | 17.1172 | 6.6419 | 2.46687 | 3.41297 | 920.49 | 67425.6 |
| 294 | 86436 | 25412184 | 17.1464 | 6.6494 | 2.46835 | 3.40136 | 923.63 | 67886.7 |
| 295 | 87025 | 25672375 | 17.1756 | 6.6569 | 2.46982 | 3.38983 | 926.77 | 68349.3 |
| 296 | 87616 | 25934336 | 17.2047 | 6.6644 | 2.47129 | 3.37838 | 929.91 | 68813.4 |
| 297 | 88209 | 26198073 | 17.2337 | 6.6719 | 2.47276 | 3.36700 | 933.05 | 69279.2 |
| 298 | 88804 | 26463592 | 17.2627 | 6.6794 | 2.47422 | 3.35570 | 936.19 | 69746.5 |
| 299 | 89401 | 26730899 | 17.2916 | 6.6869 | 2.47567 | 3.34448 | 939.34 | 70215.4 |

# Functions of Numbers, 200 to 249

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 200 | 40000 | 8000000 | 14.1421 | 5.8480 | 2.30103 | 5.00000 | 628.32 | 31415.9 |
| 201 | 40401 | 8120601 | 14.1774 | 5.8578 | 2.30320 | 4.97512 | 631.46 | 31730.9 |
| 202 | 40804 | 8242408 | 14.2127 | 5.8675 | 2.30535 | 4.95050 | 634.60 | 32047.4 |
| 203 | 41209 | 8365427 | 14.2478 | 5.8771 | 2.30750 | 4.92611 | 637.74 | 32365.5 |
| 204 | 41616 | 8489664 | 14.2829 | 5.8868 | 2.30963 | 4.90196 | 640.88 | 32685.1 |
| 205 | 42025 | 8615125 | 14.3178 | 5.8964 | 2.31175 | 4.87805 | 644.03 | 33006.4 |
| 206 | 42436 | 8741816 | 14.3527 | 5.9059 | 2.31387 | 4.85437 | 647.17 | 33329.2 |
| 207 | 42849 | 8869743 | 14.3875 | 5.9155 | 2.31597 | 4.83092 | 650.31 | 33653.5 |
| 208 | 43264 | 8998912 | 14.4222 | 5.9250 | 2.31806 | 4.80769 | 653.45 | 33979.5 |
| 209 | 43681 | 9129329 | 14.4568 | 5.9345 | 2.32015 | 4.78469 | 656.59 | 34307.0 |
| 210 | 44100 | 9261000 | 14.4914 | 5.9439 | 2.32222 | 4.76190 | 659.73 | 34636.1 |
| 211 | 44521 | 9393931 | 14.5258 | 5.9533 | 2.32428 | 4.73934 | 662.88 | 34966.7 |
| 212 | 44944 | 9528128 | 14.5602 | 5.9627 | 2.32634 | 4.71698 | 666.02 | 35298.9 |
| 213 | 45369 | 9663597 | 14.5945 | 5.9721 | 2.32838 | 4.69484 | 669.16 | 35632.7 |
| 214 | 45796 | 9800344 | 14.6287 | 5.9814 | 2.33041 | 4.67290 | 672.30 | 35968.1 |
| 215 | 46225 | 9938375 | 14.6629 | 5.9907 | 2.33244 | 4.65116 | 675.44 | 36305.0 |
| 216 | 46656 | 10077696 | 14.6969 | 6.0000 | 2.33445 | 4.62963 | 678.58 | 36643.5 |
| 217 | 47089 | 10218313 | 14.7309 | 6.0092 | 2.33646 | 4.60829 | 681.73 | 36983.6 |
| 218 | 47524 | 10360232 | 14.7648 | 6.0185 | 2.33846 | 4.58716 | 684.87 | 37325.3 |
| 219 | 47961 | 10503459 | 14.7986 | 6.0277 | 2.34044 | 4.56621 | 688.01 | 37668.5 |
| 220 | 48400 | 10648000 | 14.8324 | 6.0368 | 2.34242 | 4.54545 | 691.15 | 38013.3 |
| 221 | 48841 | 10793861 | 14.8661 | 6.0459 | 2.34439 | 4.52489 | 694.29 | 38359.6 |
| 222 | 49284 | 10941048 | 14.8997 | 6.0550 | 2.34635 | 4.50450 | 697.43 | 38707.6 |
| 223 | 49729 | 11089567 | 14.9332 | 6.0641 | 2.34830 | 4.48430 | 700.58 | 39057.1 |
| 224 | 50176 | 11239424 | 14.9666 | 6.0732 | 2.35025 | 4.46429 | 703.72 | 39408.1 |
| 225 | 50625 | 11390625 | 15.0000 | 6.0822 | 2.35218 | 4.44444 | 706.86 | 39760.8 |
| 226 | 51076 | 11543176 | 15.0333 | 6.0912 | 2.35411 | 4.42478 | 710.00 | 40115.0 |
| 227 | 51529 | 11697083 | 15.0665 | 6.1002 | 2.35603 | 4.40529 | 713.14 | 40470.8 |
| 228 | 51984 | 11852352 | 15.0997 | 6.1091 | 2.35793 | 4.38596 | 716.28 | 40828.1 |
| 229 | 52441 | 12008989 | 15.1327 | 6.1180 | 2.35984 | 4.36681 | 719.42 | 41187.1 |
| 230 | 52900 | 12167000 | 15.1658 | 6.1269 | 2.36173 | 4.34783 | 722.57 | 41547.6 |
| 231 | 53361 | 12326391 | 15.1987 | 6.1358 | 2.36361 | 4.32900 | 725.71 | 41909.6 |
| 232 | 53824 | 12487168 | 15.2315 | 6.1446 | 2.36549 | 4.31034 | 728.85 | 42273.3 |
| 233 | 54289 | 12649337 | 15.2643 | 6.1534 | 2.36736 | 4.29185 | 731.99 | 42638.5 |
| 234 | 54756 | 12812904 | 15.2971 | 6.1622 | 2.36922 | 4.27350 | 735.13 | 43005.3 |
| 235 | 55225 | 12977875 | 15.3297 | 6.1710 | 2.37107 | 4.25532 | 738.27 | 43373.6 |
| 236 | 55696 | 13144256 | 15.3623 | 6.1797 | 2.37291 | 4.23729 | 741.42 | 43743.5 |
| 237 | 56169 | 13312053 | 15.3948 | 6.1885 | 2.37475 | 4.21941 | 744.56 | 44115.0 |
| 238 | 56644 | 13481272 | 15.4272 | 6.1972 | 2.37658 | 4.20168 | 747.70 | 44488.1 |
| 239 | 57121 | 13651919 | 15.4596 | 6.2058 | 2.37840 | 4.18410 | 750.84 | 44862.7 |
| 240 | 57600 | 13824000 | 15.4919 | 6.2145 | 2.38021 | 4.16667 | 753.98 | 45238.9 |
| 241 | 58081 | 13997521 | 15.5242 | 6.2231 | 2.38202 | 4.14938 | 757.12 | 45616.7 |
| 242 | 58564 | 14172488 | 15.5563 | 6.2317 | 2.38382 | 4.13223 | 760.27 | 45996.1 |
| 243 | 59049 | 14348907 | 15.5885 | 6.2403 | 2.38561 | 4.11523 | 763.41 | 46377.0 |
| 244 | 59536 | 14526784 | 15.6205 | 6.2488 | 2.38739 | 4.09836 | 766.55 | 46759.5 |
| 245 | 60025 | 14706125 | 15.6525 | 6.2573 | 2.38917 | 4.08163 | 769.69 | 47143.5 |
| 246 | 60516 | 14886936 | 15.6844 | 6.2658 | 2.39094 | 4.06504 | 772.83 | 47529.2 |
| 247 | 61009 | 15069223 | 15.7162 | 6.2743 | 2.39270 | 4.04858 | 775.97 | 47916.4 |
| 248 | 61504 | 15252992 | 15.7480 | 6.2828 | 2.39445 | 4.03226 | 779.12 | 48305.1 |
| 249 | 62001 | 15438249 | 15.7797 | 6.2912 | 2.39620 | 4.01606 | 782.26 | 48695.5 |

# Functions of Numbers, 250 to 299

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 250 | 62500 | 15625000 | 15.8114 | 6.2996 | 2.39794 | 4.00000 | 785.40 | 49087.4 |
| 251 | 63001 | 15813251 | 15.8430 | 6.3080 | 2.39967 | 3.98406 | 788.54 | 49480.9 |
| 252 | 63504 | 16003008 | 15.8745 | 6.3164 | 2.40140 | 3.96825 | 791.68 | 49875.9 |
| 253 | 64009 | 16194277 | 15.9060 | 6.3247 | 2.40312 | 3.95257 | 794.82 | 50272.6 |
| 254 | 64516 | 16387064 | 15.9374 | 6.3330 | 2.40483 | 3.93701 | 797.96 | 50670.7 |
| 255 | 65025 | 16581375 | 15.9687 | 6.3413 | 2.40654 | 3.92157 | 801.11 | 51070.5 |
| 256 | 65536 | 16777216 | 16.0000 | 6.3496 | 2.40824 | 3.90625 | 804.25 | 51471.9 |
| 257 | 66049 | 16974593 | 16.0312 | 6.3579 | 2.40993 | 3.89105 | 807.39 | 51874.8 |
| 258 | 66564 | 17173512 | 16.0624 | 6.3661 | 2.41162 | 3.87597 | 810.53 | 52279.2 |
| 259 | 67081 | 17373979 | 16.0935 | 6.3743 | 2.41330 | 3.86100 | 813.67 | 52685.3 |
| 260 | 67600 | 17576000 | 16.1245 | 6.3825 | 2.41497 | 3.84615 | 816.81 | 53092.9 |
| 261 | 68121 | 17779581 | 16.1555 | 6.3907 | 2.41664 | 3.83142 | 819.96 | 53502.1 |
| 262 | 68644 | 17984728 | 16.1864 | 6.3988 | 2.41830 | 3.81679 | 823.10 | 53912.9 |
| 263 | 69169 | 18191447 | 16.2173 | 6.4070 | 2.41996 | 3.80228 | 826.24 | 54325.2 |
| 264 | 69696 | 18399744 | 16.2481 | 6.4151 | 2.42160 | 3.78788 | 829.38 | 54739.1 |
| 265 | 70225 | 18609625 | 16.2788 | 6.4232 | 2.42325 | 3.77358 | 832.52 | 55154.6 |
| 266 | 70756 | 18821096 | 16.3095 | 6.4312 | 2.42488 | 3.75940 | 835.66 | 55571.6 |
| 267 | 71289 | 19034163 | 16.3401 | 6.4393 | 2.42651 | 3.74532 | 838.81 | 55990.2 |
| 268 | 71824 | 19248832 | 16.3707 | 6.4473 | 2.42813 | 3.73134 | 841.95 | 56410.4 |
| 269 | 72361 | 19465109 | 16.4012 | 6.4553 | 2.42975 | 3.71747 | 845.09 | 56832.2 |
| 270 | 72900 | 19683000 | 16.4317 | 6.4633 | 2.43136 | 3.70370 | 848.23 | 57255.5 |
| 271 | 73441 | 19902511 | 16.4621 | 6.4713 | 2.43297 | 3.69004 | 851.37 | 57680.4 |
| 272 | 73984 | 20123648 | 16.4924 | 6.4792 | 2.43457 | 3.67647 | 854.51 | 58106.9 |
| 273 | 74529 | 20346417 | 16.5227 | 6.4872 | 2.43616 | 3.66300 | 857.65 | 58534.9 |
| 274 | 75076 | 20570824 | 16.5529 | 6.4951 | 2.43775 | 3.64964 | 860.80 | 58964.6 |
| 275 | 75625 | 20796875 | 16.5831 | 6.5030 | 2.43933 | 3.63636 | 863.94 | 59395.7 |
| 276 | 76176 | 21024576 | 16.6132 | 6.5108 | 2.44091 | 3.62319 | 867.08 | 59828.5 |
| 277 | 76729 | 21253933 | 16.6433 | 6.5187 | 2.44248 | 3.61011 | 870.22 | 60262.8 |
| 278 | 77284 | 21484952 | 16.6733 | 6.5265 | 2.44404 | 3.59712 | 873.36 | 60698.7 |
| 279 | 77841 | 21717639 | 16.7033 | 6.5343 | 2.44560 | 3.58423 | 876.50 | 61136.2 |
| 280 | 78400 | 21952000 | 16.7332 | 6.5421 | 2.44716 | 3.57143 | 879.65 | 61575.2 |
| 281 | 78961 | 22188041 | 16.7631 | 6.5499 | 2.44871 | 3.55872 | 882.79 | 62015.8 |
| 282 | 79524 | 22425768 | 16.7929 | 6.5577 | 2.45025 | 3.54610 | 885.93 | 62458.0 |
| 283 | 80089 | 22665187 | 16.8226 | 6.5654 | 2.45179 | 3.53357 | 889.07 | 62901.8 |
| 284 | 80656 | 22906304 | 16.8523 | 6.5731 | 2.45332 | 3.52113 | 892.21 | 63347.1 |
| 285 | 81225 | 23149125 | 16.8819 | 6.5808 | 2.45484 | 3.50877 | 895.35 | 63794.0 |
| 286 | 81796 | 23393656 | 16.9115 | 6.5885 | 2.45637 | 3.49650 | 898.50 | 64242.4 |
| 287 | 82369 | 23639903 | 16.9411 | 6.5962 | 2.45788 | 3.48432 | 901.64 | 64692.5 |
| 288 | 82944 | 23887872 | 16.9706 | 6.6039 | 2.45939 | 3.47222 | 904.78 | 65144.1 |
| 289 | 83521 | 24137569 | 17.0000 | 6.6115 | 2.46090 | 3.46021 | 907.92 | 65597.2 |
| 290 | 84100 | 24389000 | 17.0294 | 6.6191 | 2.46240 | 3.44828 | 911.06 | 66052.0 |
| 291 | 84681 | 24642171 | 17.0587 | 6.6267 | 2.46389 | 3.43643 | 914.20 | 66508.3 |
| 292 | 85264 | 24897088 | 17.0880 | 6.6343 | 2.46538 | 3.42466 | 917.35 | 66966.2 |
| 293 | 85849 | 25153757 | 17.1172 | 6.6419 | 2.46687 | 3.41297 | 920.49 | 67425.6 |
| 294 | 86436 | 25412184 | 17.1464 | 6.6494 | 2.46835 | 3.40136 | 923.63 | 67886.7 |
| 295 | 87025 | 25672375 | 17.1756 | 6.6569 | 2.46982 | 3.38983 | 926.77 | 68349.3 |
| 296 | 87616 | 25934336 | 17.2047 | 6.6644 | 2.47129 | 3.37838 | 929.91 | 68813.4 |
| 297 | 88209 | 26198073 | 17.2337 | 6.6719 | 2.47276 | 3.36700 | 933.05 | 69279.2 |
| 298 | 88804 | 26463592 | 17.2627 | 6.6794 | 2.47422 | 3.35570 | 936.19 | 69746.5 |
| 299 | 89401 | 26730899 | 17.2916 | 6.6869 | 2.47567 | 3.34448 | 939.34 | 70215.4 |

# Functions of Numbers, 300 to 349

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 300 | 90000 | 27000000 | 17.3205 | 6.6943 | 2.47712 | 3.33333 | 942.48 | 70685.8 |
| 301 | 90601 | 27270901 | 17.3494 | 6.7018 | 2.47857 | 3.32226 | 945.62 | 71157.9 |
| 302 | 91204 | 27543608 | 17.3781 | 6.7092 | 2.48001 | 3.31126 | 948.76 | 71631.5 |
| 303 | 91809 | 27818127 | 17.4069 | 6.7166 | 2.48144 | 3.30033 | 951.90 | 72106.6 |
| 304 | 92416 | 28094464 | 17.4356 | 6.7240 | 2.48287 | 3.28947 | 955.04 | 72583.4 |
| 305 | 93025 | 28372625 | 17.4642 | 6.7313 | 2.48430 | 3.27869 | 958.19 | 73061.7 |
| 306 | 93636 | 28652616 | 17.4929 | 6.7387 | 2.48572 | 3.26797 | 961.33 | 73541.5 |
| 307 | 94249 | 28934443 | 17.5214 | 6.7460 | 2.48714 | 3.25733 | 964.47 | 74023.0 |
| 308 | 94864 | 29218112 | 17.5499 | 6.7533 | 2.48855 | 3.24675 | 967.61 | 74506.0 |
| 309 | 95481 | 29503629 | 17.5784 | 6.7606 | 2.48996 | 3.23625 | 970.75 | 74990.6 |
| 310 | 96100 | 29791000 | 17.6068 | 6.7679 | 2.49136 | 3.22581 | 973.89 | 75476.8 |
| 311 | 96721 | 30080231 | 17.6352 | 6.7752 | 2.49276 | 3.21543 | 977.04 | 75964.5 |
| 312 | 97344 | 30371328 | 17.6635 | 6.7824 | 2.49415 | 3.20513 | 980.18 | 76453.8 |
| 313 | 97969 | 30664297 | 17.6918 | 6.7897 | 2.49554 | 3.19489 | 983.32 | 76944.7 |
| 314 | 98596 | 30959144 | 17.7200 | 6.7969 | 2.49693 | 3.18471 | 986.46 | 77437.1 |
| 315 | 99225 | 31255875 | 17.7482 | 6.8041 | 2.49831 | 3.17460 | 989.60 | 77931.1 |
| 316 | 99856 | 31554496 | 17.7764 | 6.8113 | 2.49969 | 3.16456 | 992.74 | 78426.7 |
| 317 | 100489 | 31855013 | 17.8045 | 6.8185 | 2.50106 | 3.15457 | 995.88 | 78923.9 |
| 318 | 101124 | 32157432 | 17.8326 | 6.8256 | 2.50243 | 3.14465 | 999.03 | 79422.6 |
| 319 | 101761 | 32461759 | 17.8606 | 6.8328 | 2.50379 | 3.13480 | 1002.2 | 79922.9 |
| 320 | 102400 | 32768000 | 17.8885 | 6.8399 | 2.50515 | 3.12500 | 1005.3 | 80424.8 |
| 321 | 103041 | 33076161 | 17.9165 | 6.8470 | 2.50651 | 3.11526 | 1008.5 | 80928.2 |
| 322 | 103684 | 33386248 | 17.9444 | 6.8541 | 2.50786 | 3.10559 | 1011.6 | 81433.2 |
| 323 | 104329 | 33698267 | 17.9722 | 6.8612 | 2.50920 | 3.09598 | 1014.7 | 81939.8 |
| 324 | 104976 | 34012224 | 18.0000 | 6.8683 | 2.51055 | 3.08642 | 1017.9 | 82448.0 |
| 325 | 105625 | 34328125 | 18.0278 | 6.8753 | 2.51188 | 3.07692 | 1021.0 | 82957.7 |
| 326 | 106276 | 34645976 | 18.0555 | 6.8824 | 2.51322 | 3.06749 | 1024.2 | 83469.0 |
| 327 | 106929 | 34965783 | 18.0831 | 6.8894 | 2.51455 | 3.05810 | 1027.3 | 83981.8 |
| 328 | 107584 | 35287552 | 18.1108 | 6.8964 | 2.51587 | 3.04878 | 1030.4 | 84496.3 |
| 329 | 108241 | 35611289 | 18.1384 | 6.9034 | 2.51720 | 3.03951 | 1033.6 | 85012.3 |
| 330 | 108900 | 35937000 | 18.1659 | 6.9104 | 2.51851 | 3.03030 | 1036.7 | 85529.9 |
| 331 | 109561 | 36264691 | 18.1934 | 6.9174 | 2.51983 | 3.02115 | 1039.9 | 86049.0 |
| 332 | 110224 | 36594368 | 18.2209 | 6.9244 | 2.52114 | 3.01205 | 1043.0 | 86569.7 |
| 333 | 110889 | 36926037 | 18.2483 | 6.9313 | 2.52244 | 3.00300 | 1046.2 | 87092.0 |
| 334 | 111556 | 37259704 | 18.2757 | 6.9382 | 2.52375 | 2.99401 | 1049.3 | 87615.9 |
| 335 | 112225 | 37595375 | 18.3030 | 6.9451 | 2.52504 | 2.98507 | 1052.4 | 88141.3 |
| 336 | 112896 | 37933056 | 18.3303 | 6.9521 | 2.52634 | 2.97619 | 1055.6 | 88668.3 |
| 337 | 113569 | 38272753 | 18.3576 | 6.9589 | 2.52763 | 2.96736 | 1058.7 | 89196.9 |
| 338 | 114244 | 38614472 | 18.3848 | 6.9658 | 2.52892 | 2.95858 | 1061.9 | 89727.0 |
| 339 | 114921 | 38958219 | 18.4120 | 6.9727 | 2.53020 | 2.94985 | 1065.0 | 90258.7 |
| 340 | 115600 | 39304000 | 18.4391 | 6.9795 | 2.53148 | 2.94118 | 1068.1 | 90792.0 |
| 341 | 116281 | 39651821 | 18.4662 | 6.9864 | 2.53275 | 2.93255 | 1071.3 | 91326.9 |
| 342 | 116964 | 40001688 | 18.4932 | 6.9932 | 2.53403 | 2.92398 | 1074.4 | 91863.3 |
| 343 | 117649 | 40353607 | 18.5203 | 7.0000 | 2.53529 | 2.91545 | 1077.6 | 92401.3 |
| 344 | 118336 | 40707584 | 18.5472 | 7.0068 | 2.53656 | 2.90698 | 1080.7 | 92940.9 |
| 345 | 119025 | 41063625 | 18.5742 | 7.0136 | 2.53782 | 2.89855 | 1083.8 | 93482.0 |
| 346 | 119716 | 41421736 | 18.6011 | 7.0203 | 2.53908 | 2.89017 | 1087.0 | 94024.7 |
| 347 | 120409 | 41781923 | 18.6279 | 7.0271 | 2.54033 | 2.88184 | 1090.1 | 94569.0 |
| 348 | 121104 | 42144192 | 18.6548 | 7.0338 | 2.54158 | 2.87356 | 1093.3 | 95114.9 |
| 349 | 121801 | 42508549 | 18.6815 | 7.0406 | 2.54283 | 2.86533 | 1096.4 | 95662.3 |

# Functions of Numbers, 350 to 399

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter Circum. | No. = Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 350 | 122500 | 42875000 | 18.7083 | 7.0473 | 2.54407 | 2.85714 | 1099.6 | 96211.3 |
| 351 | 123201 | 43243551 | 18.7350 | 7.0540 | 2.54531 | 2.84900 | 1102.7 | 96761.8 |
| 352 | 123904 | 43614208 | 18.7617 | 7.0607 | 2.54654 | 2.84091 | 1105.8 | 97314.0 |
| 353 | 124609 | 43986977 | 18.7883 | 7.0674 | 2.54777 | 2.83286 | 1109.0 | 97867.7 |
| 354 | 125316 | 44361864 | 18.8149 | 7.0740 | 2.54900 | 2.82486 | 1112.1 | 98423.0 |
| 355 | 126025 | 44738875 | 18.8414 | 7.0807 | 2.55023 | 2.81690 | 1115.3 | 98979.8 |
| 356 | 126736 | 45118016 | 18.8680 | 7.0873 | 2.55145 | 2.80899 | 1118.4 | 99538.2 |
| 357 | 127449 | 45499293 | 18.8944 | 7.0940 | 2.55267 | 2.80112 | 1121.5 | 100098 |
| 358 | 128164 | 45882712 | 18.9209 | 7.1006 | 2.55388 | 2.79330 | 1124.7 | 100660 |
| 359 | 128881 | 46268279 | 18.9473 | 7.1072 | 2.55509 | 2.78552 | 1127.8 | 101223 |
| 360 | 129600 | 46656000 | 18.9737 | 7.1138 | 2.55630 | 2.77778 | 1131.0 | 101788 |
| 361 | 130321 | 47045881 | 19.0000 | 7.1204 | 2.55751 | 2.77008 | 1134.1 | 102354 |
| 362 | 131044 | 47437928 | 19.0263 | 7.1269 | 2.55871 | 2.76243 | 1137.3 | 102922 |
| 363 | 131769 | 47832147 | 19.0526 | 7.1335 | 2.55991 | 2.75482 | 1140.4 | 103491 |
| 364 | 132496 | 48228544 | 19.0788 | 7.1400 | 2.56110 | 2.74725 | 1143.5 | 104062 |
| 365 | 133225 | 48627125 | 19.1050 | 7.1466 | 2.56229 | 2.73973 | 1146.7 | 104635 |
| 366 | 133956 | 49027896 | 19.1311 | 7.1531 | 2.56348 | 2.73224 | 1149.8 | 105209 |
| 367 | 134689 | 49430863 | 19.1572 | 7.1596 | 2.56467 | 2.72480 | 1153.0 | 105785 |
| 368 | 135424 | 49836032 | 19.1833 | 7.1661 | 2.56585 | 2.71739 | 1156.1 | 106362 |
| 369 | 136161 | 50243409 | 19.2094 | 7.1726 | 2.56703 | 2.71003 | 1159.2 | 106941 |
| 370 | 136900 | 50653000 | 19.2354 | 7.1791 | 2.56820 | 2.70270 | 1162.4 | 107521 |
| 371 | 137641 | 51064811 | 19.2614 | 7.1855 | 2.56937 | 2.69542 | 1165.5 | 108103 |
| 372 | 138384 | 51478848 | 19.2873 | 7.1920 | 2.57054 | 2.68817 | 1168.7 | 108687 |
| 373 | 139129 | 51895117 | 19.3132 | 7.1984 | 2.57171 | 2.68097 | 1171.8 | 109272 |
| 374 | 139876 | 52313624 | 19.3391 | 7.2048 | 2.57287 | 2.67380 | 1175.0 | 109858 |
| 375 | 140625 | 52734375 | 19.3649 | 7.2112 | 2.57403 | 2.66667 | 1178.1 | 110447 |
| 376 | 141376 | 53157376 | 19.3907 | 7.2177 | 2.57519 | 2.65957 | 1181.2 | 111036 |
| 377 | 142129 | 53582633 | 19.4165 | 7.2240 | 2.57634 | 2.65252 | 1184.4 | 111628 |
| 378 | 142884 | 54010152 | 19.4422 | 7.2304 | 2.57749 | 2.64550 | 1187.5 | 112221 |
| 379 | 143641 | 54439939 | 19.4679 | 7.2368 | 2.57864 | 2.63852 | 1190.7 | 112815 |
| 380 | 144400 | 54872000 | 19.4936 | 7.2432 | 2.57978 | 2.63158 | 1193.8 | 113411 |
| 381 | 145161 | 55306341 | 19.5192 | 7.2495 | 2.58093 | 2.62467 | 1196.9 | 114009 |
| 382 | 145924 | 55742968 | 19.5448 | 7.2558 | 2.58206 | 2.61780 | 1200.1 | 114608 |
| 383 | 146689 | 56181887 | 19.5704 | 7.2622 | 2.58320 | 2.61097 | 1203.2 | 115209 |
| 384 | 147456 | 56623104 | 19.5959 | 7.2685 | 2.58433 | 2.60417 | 1206.4 | 115812 |
| 385 | 148225 | 57066625 | 19.6214 | 7.2748 | 2.58546 | 2.59740 | 1209.5 | 116416 |
| 386 | 148996 | 57512456 | 19.6469 | 7.2811 | 2.58659 | 2.59067 | 1212.7 | 117021 |
| 387 | 149769 | 57960603 | 19.6723 | 7.2874 | 2.58771 | 2.58398 | 1215.8 | 117628 |
| 388 | 150544 | 58411072 | 19.6977 | 7.2936 | 2.58883 | 2.57732 | 1218.9 | 118237 |
| 389 | 151321 | 58863869 | 19.7231 | 7.2999 | 2.58995 | 2.57069 | 1222.1 | 118847 |
| 390 | 152100 | 59319000 | 19.7484 | 7.3061 | 2.59106 | 2.56410 | 1225.2 | 119459 |
| 391 | 152881 | 59776471 | 19.7737 | 7.3124 | 2.59218 | 2.55754 | 1228.4 | 120072 |
| 392 | 153664 | 60236288 | 19.7990 | 7.3186 | 2.59329 | 2.55102 | 1231.5 | 120687 |
| 393 | 154449 | 60698457 | 19.8242 | 7.3248 | 2.59439 | 2.54453 | 1234.6 | 121304 |
| 394 | 155236 | 61162984 | 19.8494 | 7.3310 | 2.59550 | 2.53807 | 1237.8 | 121922 |
| 395 | 156025 | 61629875 | 19.8746 | 7.3372 | 2.59660 | 2.53165 | 1240.9 | 122542 |
| 396 | 156816 | 62099136 | 19.8997 | 7.3434 | 2.59770 | 2.52525 | 1244.1 | 123163 |
| 397 | 157609 | 62570773 | 19.9249 | 7.3496 | 2.59879 | 2.51889 | 1247.2 | 123786 |
| 398 | 158404 | 63044792 | 19.9499 | 7.3558 | 2.59988 | 2.51256 | 1250.4 | 124410 |
| 399 | 159201 | 63521199 | 19.9750 | 7.3619 | 2.60097 | 2.50627 | 1253.5 | 125036 |

# Functions of Numbers, 400 to 449

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 400 | 160000 | 64000000 | 20.0000 | 7.3681 | 2.60206 | 2.50000 | 1256.6 | 125664 |
| 401 | 160801 | 64481201 | 20.0250 | 7.3742 | 2.60314 | 2.49377 | 1259.8 | 126293 |
| 402 | 161604 | 64964808 | 20.0499 | 7.3803 | 2.60423 | 2.48756 | 1262.9 | 126923 |
| 403 | 162409 | 65450827 | 20.0749 | 7.3864 | 2.60531 | 2.48139 | 1266.1 | 127556 |
| 404 | 163216 | 65939264 | 20.0998 | 7.3925 | 2.60638 | 2.47525 | 1269.2 | 128190 |
| 405 | 164025 | 66430125 | 20.1246 | 7.3986 | 2.60746 | 2.46914 | 1272.3 | 128825 |
| 406 | 164836 | 66923416 | 20.1494 | 7.4047 | 2.60853 | 2.46305 | 1275.5 | 129462 |
| 407 | 165649 | 67419143 | 20.1742 | 7.4108 | 2.60959 | 2.45700 | 1278.6 | 130100 |
| 408 | 166464 | 67917312 | 20.1990 | 7.4169 | 2.61066 | 2.45098 | 1281.8 | 130741 |
| 409 | 167281 | 68417929 | 20.2237 | 7.4229 | 2.61172 | 2.44499 | 1284.9 | 131382 |
| 410 | 168100 | 68921000 | 20.2485 | 7.4290 | 2.61278 | 2.43902 | 1288.1 | 132025 |
| 411 | 168921 | 69426531 | 20.2731 | 7.4350 | 2.61384 | 2.43309 | 1291.2 | 132670 |
| 412 | 169744 | 69934528 | 20.2978 | 7.4410 | 2.61490 | 2.42718 | 1294.3 | 133317 |
| 413 | 170569 | 70444997 | 20.3224 | 7.4470 | 2.61595 | 2.42131 | 1297.5 | 133965 |
| 414 | 171396 | 70957944 | 20.3470 | 7.4530 | 2.61700 | 2.41546 | 1300.6 | 134614 |
| 415 | 172225 | 71473375 | 20.3715 | 7.4590 | 2.61805 | 2.40964 | 1303.8 | 135265 |
| 416 | 173056 | 71991296 | 20.3961 | 7.4650 | 2.61909 | 2.40385 | 1306.9 | 135918 |
| 417 | 173889 | 72511713 | 20.4206 | 7.4710 | 2.62014 | 2.39808 | 1310.0 | 136572 |
| 418 | 174724 | 73034632 | 20.4450 | 7.4770 | 2.62118 | 2.39234 | 1313.2 | 137228 |
| 419 | 175561 | 73560059 | 20.4695 | 7.4829 | 2.62221 | 2.38663 | 1316.3 | 137885 |
| 420 | 176400 | 74088000 | 20.4939 | 7.4889 | 2.62325 | 2.38095 | 1319.5 | 138544 |
| 421 | 177241 | 74618461 | 20.5183 | 7.4948 | 2.62428 | 2.37530 | 1322.6 | 139205 |
| 422 | 178084 | 75151448 | 20.5426 | 7.5007 | 2.62531 | 2.36967 | 1325.8 | 139867 |
| 423 | 178929 | 75686967 | 20.5670 | 7.5067 | 2.62634 | 2.36407 | 1328.9 | 140531 |
| 424 | 179776 | 76225024 | 20.5913 | 7.5126 | 2.62737 | 2.35849 | 1332.0 | 141196 |
| 425 | 180625 | 76765625 | 20.6155 | 7.5185 | 2.62839 | 2.35294 | 1335.2 | 141863 |
| 426 | 181476 | 77308776 | 20.6398 | 7.5244 | 2.62941 | 2.34742 | 1338.3 | 142531 |
| 427 | 182329 | 77854483 | 20.6640 | 7.5302 | 2.63043 | 2.34192 | 1341.5 | 143201 |
| 428 | 183184 | 78402752 | 20.6882 | 7.5361 | 2.63144 | 2.33645 | 1344.6 | 143872 |
| 429 | 184041 | 78953589 | 20.7123 | 7.5420 | 2.63246 | 2.33100 | 1347.7 | 144545 |
| 430 | 184900 | 79507000 | 20.7364 | 7.5478 | 2.63347 | 2.32558 | 1350.9 | 145220 |
| 431 | 185761 | 80062991 | 20.7605 | 7.5537 | 2.63448 | 2.32019 | 1354.0 | 145896 |
| 432 | 186624 | 80621568 | 20.7846 | 7.5595 | 2.63548 | 2.31481 | 1357.2 | 146574 |
| 433 | 187489 | 81182737 | 20.8087 | 7.5654 | 2.63649 | 2.30947 | 1360.3 | 147254 |
| 434 | 188356 | 81746504 | 20.8327 | 7.5712 | 2.63749 | 2.30415 | 1363.5 | 147934 |
| 435 | 189225 | 82312875 | 20.8567 | 7.5770 | 2.63849 | 2.29885 | 1366.6 | 148617 |
| 436 | 190096 | 82881856 | 20.8806 | 7.5828 | 2.63949 | 2.29358 | 1369.7 | 149301 |
| 437 | 190969 | 83453453 | 20.9045 | 7.5886 | 2.64048 | 2.28833 | 1372.9 | 149987 |
| 438 | 191844 | 84027672 | 20.9284 | 7.5944 | 2.64147 | 2.28311 | 1376.0 | 150674 |
| 439 | 192721 | 84604519 | 20.9523 | 7.6001 | 2.64246 | 2.27790 | 1379.2 | 151363 |
| 440 | 193600 | 85184000 | 20.9762 | 7.6059 | 2.64345 | 2.27273 | 1382.3 | 152053 |
| 441 | 194481 | 85766121 | 21.0000 | 7.6117 | 2.64444 | 2.26757 | 1385.4 | 152745 |
| 442 | 195364 | 86350888 | 21.0238 | 7.6174 | 2.64542 | 2.26244 | 1388.6 | 153439 |
| 443 | 196249 | 86938307 | 21.0476 | 7.6232 | 2.64640 | 2.25734 | 1391.7 | 154134 |
| 444 | 197136 | 87528384 | 21.0713 | 7.6289 | 2.64738 | 2.25225 | 1394.9 | 154830 |
| 445 | 198025 | 88121125 | 21.0950 | 7.6346 | 2.64836 | 2.24719 | 1398.0 | 155528 |
| 446 | 198916 | 88716536 | 21.1187 | 7.6403 | 2.64933 | 2.24215 | 1401.2 | 156228 |
| 447 | 199809 | 89314623 | 21.1424 | 7.6460 | 2.65031 | 2.23714 | 1404.3 | 156930 |
| 448 | 200704 | 89915392 | 21.1660 | 7.6517 | 2.65128 | 2.23214 | 1407.4 | 157633 |
| 449 | 201601 | 90518849 | 21.1896 | 7.6574 | 2.65225 | 2.22717 | 1410.6 | 158337 |

# Functions of Numbers, 450 to 499

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter Circum. | No.=Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 450 | 202500 | 91125000 | 21.2132 | 7.6631 | 2.65321 | 2.22222 | 1413.7 | 159043 |
| 451 | 203401 | 91733851 | 21.2368 | 7.6688 | 2.65418 | 2.21729 | 1416.9 | 159751 |
| 452 | 204304 | 92345408 | 21.2603 | 7.6744 | 2.65514 | 2.21239 | 1420.0 | 160460 |
| 453 | 205209 | 92959677 | 21.2838 | 7.6801 | 2.65610 | 2.20751 | 1423.1 | 161171 |
| 454 | 206116 | 93576664 | 21.3073 | 7.6857 | 2.65706 | 2.20264 | 1426.3 | 161883 |
| 455 | 207025 | 94196375 | 21.3307 | 7.6914 | 2.65801 | 2.19780 | 1429.4 | 162597 |
| 456 | 207936 | 94818816 | 21.3542 | 7.6970 | 2.65896 | 2.19298 | 1432.6 | 163313 |
| 457 | 208849 | 95443993 | 21.3776 | 7.7026 | 2.65992 | 2.18818 | 1435.7 | 164030 |
| 458 | 209764 | 96071912 | 21.4009 | 7.7082 | 2.66087 | 2.18341 | 1438.8 | 164748 |
| 459 | 210681 | 96702579 | 21.4243 | 7.7138 | 2.66181 | 2.17865 | 1442.0 | 165468 |
| 460 | 211600 | 97336000 | 21.4476 | 7.7194 | 2.66276 | 2.17391 | 1445.1 | 166190 |
| 461 | 212521 | 97972181 | 21.4709 | 7.7250 | 2.66370 | 2.16920 | 1448.3 | 166914 |
| 462 | 213444 | 98611128 | 21.4942 | 7.7306 | 2.66464 | 2.16450 | 1451.4 | 167639 |
| 463 | 214369 | 99252847 | 21.5174 | 7.7362 | 2.66558 | 2.15983 | 1454.6 | 168365 |
| 464 | 215296 | 99897344 | 21.5407 | 7.7418 | 2.66652 | 2.15517 | 1457.7 | 169093 |
| 465 | 216225 | 100544625 | 21.5639 | 7.7473 | 2.66745 | 2.15054 | 1460.8 | 169823 |
| 466 | 217156 | 101194696 | 21.5870 | 7.7529 | 2.66839 | 2.14592 | 1464.0 | 170554 |
| 467 | 218089 | 101847563 | 21.6102 | 7.7584 | 2.66932 | 2.14133 | 1467.1 | 171287 |
| 468 | 219024 | 102503232 | 21.6333 | 7.7639 | 2.67025 | 2.13675 | 1470.3 | 172021 |
| 469 | 219961 | 103161709 | 21.6564 | 7.7695 | 2.67117 | 2.13220 | 1473.4 | 172757 |
| 470 | 220900 | 103823000 | 21.6795 | 7.7750 | 2.67210 | 2.12766 | 1476.5 | 173494 |
| 471 | 221841 | 104487111 | 21.7025 | 7.7805 | 2.67302 | 2.12314 | 1479.7 | 174234 |
| 472 | 222784 | 105154048 | 21.7256 | 7.7860 | 2.67394 | 2.11864 | 1482.8 | 174974 |
| 473 | 223729 | 105823817 | 21.7486 | 7.7915 | 2.67486 | 2.11416 | 1486.0 | 175716 |
| 474 | 224676 | 106496424 | 21.7715 | 7.7970 | 2.67578 | 2.10970 | 1489.1 | 176460 |
| 475 | 225625 | 107171875 | 21.7945 | 7.8025 | 2.67669 | 2.10526 | 1492.3 | 177205 |
| 476 | 226576 | 107850176 | 21.8174 | 7.8079 | 2.67761 | 2.10084 | 1495.4 | 177952 |
| 477 | 227529 | 108521333 | 21.8403 | 7.8134 | 2.67852 | 2.09644 | 1498.5 | 178701 |
| 478 | 228484 | 109215352 | 21.8632 | 7.8188 | 2.67943 | 2.09205 | 1501.7 | 179451 |
| 479 | 229441 | 109902239 | 21.8861 | 7.8243 | 2.68034 | 2.08768 | 1504.8 | 180203 |
| 480 | 230400 | 110592000 | 21.9089 | 7.8297 | 2.68124 | 2.08333 | 1508.0 | 180956 |
| 481 | 231361 | 111284641 | 21.9317 | 7.8352 | 2.68215 | 2.07900 | 1511.1 | 181711 |
| 482 | 232324 | 111980168 | 21.9545 | 7.8406 | 2.68305 | 2.07469 | 1514.2 | 182467 |
| 483 | 233289 | 112678587 | 21.9773 | 7.8460 | 2.68395 | 2.07039 | 1517.4 | 183225 |
| 484 | 234256 | 113379904 | 22.0000 | 7.8514 | 2.68485 | 2.06612 | 1520.5 | 183984 |
| 485 | 235225 | 114084125 | 22.0227 | 7.8568 | 2.68574 | 2.06186 | 1523.7 | 184745 |
| 486 | 236196 | 114791256 | 22.0454 | 7.8622 | 2.68664 | 2.05761 | 1526.8 | 185508 |
| 487 | 237169 | 115501303 | 22.0681 | 7.8676 | 2.68753 | 2.05339 | 1530.0 | 186272 |
| 488 | 238144 | 116214272 | 22.0907 | 7.8730 | 2.68842 | 2.04918 | 1533.1 | 187038 |
| 489 | 239121 | 116930169 | 22.1133 | 7.8784 | 2.68931 | 2.04499 | 1536.2 | 187805 |
| 490 | 240100 | 117649000 | 22.1359 | 7.8837 | 2.69020 | 2.04082 | 1539.4 | 188574 |
| 491 | 241081 | 118370771 | 22.1585 | 7.8891 | 2.69108 | 2.03666 | 1542.5 | 189345 |
| 492 | 242064 | 119095488 | 22.1811 | 7.8944 | 2.69197 | 2.03252 | 1545.7 | 190117 |
| 493 | 243049 | 119823157 | 22.2036 | 7.8998 | 2.69285 | 2.02840 | 1548.8 | 190890 |
| 494 | 244036 | 120553784 | 22.2261 | 7.9051 | 2.69373 | 2.02429 | 1551.9 | 191665 |
| 495 | 245025 | 121287375 | 22.2486 | 7.9105 | 2.69461 | 2.02020 | 1555.1 | 192442 |
| 496 | 246016 | 122023936 | 22.2711 | 7.9158 | 2.69548 | 2.01613 | 1558.2 | 193221 |
| 497 | 247009 | 122763473 | 22.2935 | 7.9211 | 2.69636 | 2.01207 | 1561.4 | 194000 |
| 498 | 248004 | 123505992 | 22.3159 | 7.9264 | 2.69723 | 2.00803 | 1564.5 | 194782 |
| 499 | 249001 | 124251499 | 22.3383 | 7.9317 | 2.69810 | 2.00401 | 1567.7 | 195565 |

# Functions of Numbers, 500 to 549

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 500 | 250000 | 125000000 | 22.3607 | 7.9370 | 2.69897 | 2.00000 | 1570.8 | 196350 |
| 501 | 251001 | 125751501 | 22.3830 | 7.9423 | 2.69984 | 1.99601 | 1573.9 | 197136 |
| 502 | 252004 | 126506008 | 22.4054 | 7.9476 | 2.70070 | 1.99203 | 1577.1 | 197923 |
| 503 | 253009 | 127263527 | 22.4277 | 7.9528 | 2.70157 | 1.98807 | 1580.2 | 198713 |
| 504 | 254016 | 128024064 | 22.4499 | 7.9581 | 2.70243 | 1.98413 | 1583.4 | 199504 |
| 505 | 255025 | 128787625 | 22.4722 | 7.9634 | 2.70329 | 1.98020 | 1586.5 | 200296 |
| 506 | 256036 | 129554216 | 22.4944 | 7.9686 | 2.70415 | 1.97628 | 1589.6 | 201090 |
| 507 | 257049 | 130323843 | 22.5167 | 7.9739 | 2.70501 | 1.97239 | 1592.8 | 201886 |
| 508 | 258064 | 131096512 | 22.5389 | 7.9791 | 2.70586 | 1.96850 | 1595.9 | 202683 |
| 509 | 259081 | 131872229 | 22.5610 | 7.9843 | 2.70672 | 1.96464 | 1599.1 | 203482 |
| 510 | 260100 | 132651000 | 22.5832 | 7.9896 | 2.70757 | 1.96078 | 1602.2 | 204282 |
| 511 | 261121 | 133432831 | 22.6053 | 7.9948 | 2.70842 | 1.95695 | 1605.4 | 205084 |
| 512 | 262144 | 134217728 | 22.6274 | 8.0000 | 2.70927 | 1.95312 | 1608.5 | 205887 |
| 513 | 263169 | 135005697 | 22.6495 | 8.0052 | 2.71012 | 1.94932 | 1611.6 | 206692 |
| 514 | 264196 | 135796744 | 22.6716 | 8.0104 | 2.71096 | 1.94553 | 1614.8 | 207499 |
| 515 | 265225 | 136590875 | 22.6936 | 8.0156 | 2.71181 | 1.94175 | 1617.9 | 208307 |
| 516 | 266256 | 137388096 | 22.7156 | 8.0208 | 2.71265 | 1.93798 | 1621.1 | 209117 |
| 517 | 267289 | 138188413 | 22.7376 | 8.0260 | 2.71349 | 1.93424 | 1624.2 | 209928 |
| 518 | 268324 | 138991832 | 22.7596 | 8.0311 | 2.71433 | 1.93050 | 1627.3 | 210741 |
| 519 | 269361 | 139798359 | 22.7816 | 8.0363 | 2.71517 | 1.92678 | 1630.5 | 211556 |
| 520 | 270400 | 140608000 | 22.8035 | 8.0415 | 2.71600 | 1.92308 | 1633.6 | 212372 |
| 521 | 271441 | 141420761 | 22.8254 | 8.0466 | 2.71684 | 1.91939 | 1636.8 | 213189 |
| 522 | 272484 | 142236648 | 22.8473 | 8.0517 | 2.71767 | 1.91571 | 1639.9 | 214008 |
| 523 | 273529 | 143055667 | 22.8692 | 8.0569 | 2.71850 | 1.91205 | 1643.1 | 214829 |
| 524 | 274576 | 143877824 | 22.8910 | 8.0620 | 2.71933 | 1.90840 | 1646.2 | 215651 |
| 525 | 275625 | 144703125 | 22.9129 | 8.0671 | 2.72016 | 1.90476 | 1649.3 | 216475 |
| 526 | 276676 | 145531576 | 22.9347 | 8.0723 | 2.72099 | 1.90114 | 1652.5 | 217301 |
| 527 | 277729 | 146363183 | 22.9565 | 8.0774 | 2.72181 | 1.89753 | 1655.6 | 218128 |
| 528 | 278784 | 147197952 | 22.9783 | 8.0825 | 2.72263 | 1.89394 | 1658.8 | 218956 |
| 529 | 279841 | 148035889 | 23.0000 | 8.0876 | 2.72346 | 1.89036 | 1661.9 | 219787 |
| 530 | 280900 | 148877000 | 23.0217 | 8.0927 | 2.72428 | 1.88679 | 1665.0 | 220618 |
| 531 | 281961 | 149721291 | 23.0434 | 8.0978 | 2.72509 | 1.88324 | 1668.2 | 221452 |
| 532 | 283024 | 150568768 | 23.0651 | 8.1028 | 2.72591 | 1.87970 | 1671.3 | 222287 |
| 533 | 284089 | 151419437 | 23.0868 | 8.1079 | 2.72673 | 1.87617 | 1674.5 | 223123 |
| 534 | 285156 | 152273304 | 23.1084 | 8.1130 | 2.72754 | 1.87266 | 1677.6 | 223961 |
| 535 | 286225 | 153130375 | 23.1301 | 8.1180 | 2.72835 | 1.86916 | 1680.8 | 224801 |
| 536 | 287296 | 153990656 | 23.1517 | 8.1231 | 2.72916 | 1.86567 | 1683.9 | 225642 |
| 537 | 288369 | 154854153 | 23.1733 | 8.1281 | 2.72997 | 1.86220 | 1687.0 | 226484 |
| 538 | 289444 | 155720872 | 23.1948 | 8.1332 | 2.73078 | 1.85874 | 1690.2 | 227329 |
| 539 | 290521 | 156590819 | 23.2164 | 8.1382 | 2.73159 | 1.85529 | 1693.3 | 228175 |
| 540 | 291600 | 157464000 | 23.2379 | 8.1433 | 2.73239 | 1.85185 | 1696.5 | 229022 |
| 541 | 292681 | 158340421 | 23.2594 | 8.1483 | 2.73320 | 1.84843 | 1699.6 | 229871 |
| 542 | 293764 | 159220088 | 23.2809 | 8.1533 | 2.73400 | 1.84502 | 1702.7 | 230722 |
| 543 | 294849 | 160103007 | 23.3024 | 8.1583 | 2.73480 | 1.84162 | 1705.9 | 231574 |
| 544 | 295936 | 160989184 | 23.3238 | 8.1633 | 2.73560 | 1.83824 | 1709.0 | 232428 |
| 545 | 297025 | 161878625 | 23.3452 | 8.1683 | 2.73640 | 1.83486 | 1712.2 | 233283 |
| 546 | 298116 | 162771336 | 23.3666 | 8.1733 | 2.73719 | 1.83150 | 1715.3 | 234140 |
| 547 | 299209 | 163667323 | 23.3880 | 8.1783 | 2.73799 | 1.82815 | 1718.5 | 234998 |
| 548 | 300304 | 164566592 | 23.4094 | 8.1833 | 2.73878 | 1.82482 | 1721.6 | 235858 |
| 549 | 301401 | 165469149 | 23.4307 | 8.1882 | 2.73957 | 1.82149 | 1724.7 | 236720 |

# Functions of Numbers, 550 to 599

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.=Diameter Circum. | No.=Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 550 | 302500 | 166375000 | 23.4521 | 8.1932 | 2.74036 | 1.81818 | 1727.9 | 237583 |
| 551 | 303601 | 167284151 | 23.4734 | 8.1982 | 2.74115 | 1.81488 | 1731.0 | 238448 |
| 552 | 304704 | 168196608 | 23.4947 | 8.2031 | 2.74194 | 1.81159 | 1734.2 | 239314 |
| 553 | 305809 | 169112377 | 23.5160 | 8.2081 | 2.74273 | 1.80832 | 1737.3 | 240182 |
| 554 | 306916 | 170031464 | 23.5372 | 8.2130 | 2.74351 | 1.80505 | 1740.4 | 241051 |
| 555 | 308025 | 170953875 | 23.5584 | 8.2180 | 2.74429 | 1.80180 | 1743.6 | 241922 |
| 556 | 309136 | 171879616 | 23.5797 | 8.2229 | 2.74507 | 1.79856 | 1746.7 | 242795 |
| 557 | 310249 | 172808693 | 23.6008 | 8.2278 | 2.74586 | 1.79533 | 1749.9 | 243669 |
| 558 | 311364 | 173741112 | 23.6220 | 8.2327 | 2.74663 | 1.79211 | 1753.0 | 244545 |
| 559 | 312481 | 174676879 | 23.6432 | 8.2377 | 2.74741 | 1.78891 | 1756.2 | 245422 |
| 560 | 313600 | 175616000 | 23.6643 | 8.2426 | 2.74819 | 1.78571 | 1759.3 | 246301 |
| 561 | 314721 | 176558481 | 23.6854 | 8.2475 | 2.74896 | 1.78253 | 1762.4 | 247181 |
| 562 | 315844 | 177504328 | 23.7065 | 8.2524 | 2.74974 | 1.77936 | 1765.6 | 248063 |
| 563 | 316969 | 178453547 | 23.7276 | 8.2573 | 2.75051 | 1.77620 | 1768.7 | 248947 |
| 564 | 318096 | 179406144 | 23.7487 | 8.2621 | 2.75128 | 1.77305 | 1771.9 | 249832 |
| 565 | 319225 | 180362125 | 23.7697 | 8.2670 | 2.75205 | 1.76991 | 1775.0 | 250719 |
| 566 | 320356 | 181321496 | 23.7908 | 8.2719 | 2.75282 | 1.76678 | 1778.1 | 251607 |
| 567 | 321489 | 182284263 | 23.8118 | 8.2768 | 2.75358 | 1.76367 | 1781.3 | 252497 |
| 568 | 322624 | 183250432 | 23.8328 | 8.2816 | 2.75435 | 1.76056 | 1784.4 | 253388 |
| 569 | 323761 | 184220009 | 23.8537 | 8.2865 | 2.75511 | 1.75747 | 1787.6 | 254281 |
| 570 | 324900 | 185193000 | 23.8747 | 8.2913 | 2.75587 | 1.75439 | 1790.7 | 255176 |
| 571 | 326041 | 186169411 | 23.8956 | 8.2962 | 2.75664 | 1.75131 | 1793.8 | 256072 |
| 572 | 327184 | 187149248 | 23.9165 | 8.3010 | 2.75740 | 1.74825 | 1797.0 | 256970 |
| 573 | 328329 | 188132517 | 23.9374 | 8.3059 | 2.75815 | 1.74520 | 1800.1 | 257869 |
| 574 | 329476 | 189119224 | 23.9583 | 8.3107 | 2.75891 | 1.74216 | 1803.3 | 258770 |
| 575 | 330625 | 190109375 | 23.9792 | 8.3155 | 2.75967 | 1.73913 | 1806.4 | 259672 |
| 576 | 331776 | 191102976 | 24.0000 | 8.3203 | 2.76042 | 1.73611 | 1809.6 | 260576 |
| 577 | 332929 | 192100033 | 24.0208 | 8.3251 | 2.76118 | 1.73310 | 1812.7 | 261482 |
| 578 | 334084 | 193100552 | 24.0416 | 8.3300 | 2.76193 | 1.73010 | 1815.8 | 262389 |
| 579 | 335241 | 194104539 | 24.0624 | 8.3348 | 2.76268 | 1.72712 | 1819.0 | 263298 |
| 580 | 336400 | 195112000 | 24.0832 | 8.3396 | 2.76343 | 1.72414 | 1822.1 | 264208 |
| 581 | 337561 | 196122941 | 24.1039 | 8.3443 | 2.76418 | 1.72117 | 1825.3 | 265120 |
| 582 | 338724 | 197137368 | 24.1247 | 8.3491 | 2.76492 | 1.71821 | 1828.4 | 266033 |
| 583 | 339889 | 198155287 | 24.1454 | 8.3539 | 2.76567 | 1.71527 | 1831.6 | 266948 |
| 584 | 341056 | 199176704 | 24.1661 | 8.3587 | 2.76641 | 1.71233 | 1834.7 | 267865 |
| 585 | 342225 | 200201625 | 24.1868 | 8.3634 | 2.76716 | 1.70940 | 1837.8 | 268783 |
| 586 | 343396 | 201230056 | 24.2074 | 8.3682 | 2.76790 | 1.70648 | 1841.0 | 269703 |
| 587 | 344569 | 202262003 | 24.2281 | 8.3730 | 2.76864 | 1.70358 | 1844.1 | 270624 |
| 588 | 345744 | 203297472 | 24.2487 | 8.3777 | 2.76938 | 1.70068 | 1847.3 | 271547 |
| 589 | 346921 | 204336469 | 24.2693 | 8.3825 | 2.77012 | 1.69779 | 1850.4 | 272471 |
| 590 | 348100 | 205379000 | 24.2899 | 8.3872 | 2.77085 | 1.69492 | 1853.5 | 273397 |
| 591 | 349281 | 206425071 | 24.3105 | 8.3919 | 2.77159 | 1.69205 | 1856.7 | 274325 |
| 592 | 350464 | 207474688 | 24.3311 | 8.3967 | 2.77232 | 1.68919 | 1859.8 | 275254 |
| 593 | 351649 | 208527857 | 24.3516 | 8.4014 | 2.77305 | 1.68634 | 1863.0 | 276184 |
| 594 | 352836 | 209584584 | 24.3721 | 8.4061 | 2.77379 | 1.68350 | 1866.1 | 277117 |
| 595 | 354025 | 210644875 | 24.3926 | 8.4108 | 2.77452 | 1.68067 | 1869.2 | 278051 |
| 596 | 355216 | 211708736 | 24.4131 | 8.4155 | 2.77525 | 1.67785 | 1872.4 | 278986 |
| 597 | 356409 | 212776173 | 24.4336 | 8.4202 | 2.77597 | 1.67504 | 1875.5 | 279923 |
| 598 | 357604 | 213847192 | 24.4540 | 8.4249 | 2.77670 | 1.67224 | 1878.7 | 280862 |
| 599 | 358801 | 214921799 | 24.4745 | 8.4296 | 2.77743 | 1.66945 | 1881.8 | 281802 |

# Functions of Numbers, 600 to 649

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No.= |
|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. |
| 600 | 360000 | 216000000 | 24.4949 | 8.4343 | 2.77815 | 1.66667 | 1885.0 |
| 601 | 361201 | 217081801 | 24.5153 | 8.4390 | 2.77887 | 1.66389 | 1888.1 |
| 602 | 362404 | 218167208 | 24.5357 | 8.4437 | 2.77960 | 1.66113 | 1891.2 |
| 603 | 363609 | 219256227 | 24.5561 | 8.4484 | 2.78032 | 1.65837 | 1894.4 |
| 604 | 364816 | 220348864 | 24.5764 | 8.4530 | 2.78104 | 1.65563 | 1897.5 |
| 605 | 366025 | 221445125 | 24.5967 | 8.4577 | 2.78176 | 1.65289 | 1900.7 |
| 606 | 367236 | 222545016 | 24.6171 | 8.4623 | 2.78247 | 1.65017 | 1903.8 |
| 607 | 368449 | 223648543 | 24.6374 | 8.4670 | 2.78319 | 1.64745 | 1906.9 |
| 608 | 369664 | 224755712 | 24.6577 | 8.4716 | 2.78390 | 1.64474 | 1910.1 |
| 609 | 370881 | 225866529 | 24.6779 | 8.4763 | 2.78462 | 1.64204 | 1913.2 |
| 610 | 372100 | 226981000 | 24.6982 | 8.4809 | 2.78533 | 1.63934 | 1916.4 |
| 611 | 373321 | 228099131 | 24.7184 | 8.4856 | 2.78604 | 1.63666 | 1919.5 |
| 612 | 374544 | 229220928 | 24.7386 | 8.4902 | 2.78675 | 1.63399 | 1922.7 |
| 613 | 375769 | 230346397 | 24.7588 | 8.4948 | 2.78746 | 1.63132 | 1925.8 |
| 614 | 376996 | 231475544 | 24.7790 | 8.4994 | 2.78817 | 1.62866 | 1928.9 |
| 615 | 378225 | 232608375 | 24.7992 | 8.5040 | 2.78888 | 1.62602 | 1932.1 |
| 616 | 379456 | 233744896 | 24.8193 | 8.5086 | 2.78958 | 1.62338 | 1935.2 |
| 617 | 380689 | 234885113 | 24.8395 | 8.5132 | 2.79029 | 1.62075 | 1938.4 |
| 618 | 381924 | 236029032 | 24.8596 | 8.5178 | 2.79099 | 1.61812 | 1941.5 |
| 619 | 383161 | 237176659 | 24.8797 | 8.5224 | 2.79169 | 1.61551 | 1944.6 |
| 620 | 384400 | 238328000 | 24.8998 | 8.5270 | 2.79239 | 1.61290 | 1947.8 |
| 621 | 385641 | 239483061 | 24.9199 | 8.5316 | 2.79309 | 1.61031 | 1950.9 |
| 622 | 386884 | 240641848 | 24.9399 | 8.5362 | 2.79379 | 1.60772 | 1954.1 |
| 623 | 388129 | 241804367 | 24.9600 | 8.5408 | 2.79449 | 1.60514 | 1957.2 |
| 624 | 389376 | 242970624 | 24.9800 | 8.5453 | 2.79518 | 1.60256 | 1960.4 |
| 625 | 390625 | 244140625 | 25.0000 | 8.5499 | 2.79588 | 1.60000 | 1963.5 |
| 626 | 391876 | 245314376 | 25.0200 | 8.5544 | 2.79657 | 1.59744 | 1966.6 |
| 627 | 393129 | 246491883 | 25.0400 | 8.5590 | 2.79727 | 1.59490 | 1969.8 |
| 628 | 394384 | 247673152 | 25.0599 | 8.5635 | 2.79796 | 1.59236 | 1972.9 |
| 629 | 395641 | 248858189 | 25.0799 | 8.5681 | 2.79865 | 1.58983 | 1976.1 |
| 630 | 396900 | 250047000 | 25.0998 | 8.5726 | 2.79934 | 1.58730 | 1979.2 |
| 631 | 398161 | 251239591 | 25.1197 | 8.5772 | 2.80003 | 1.58479 | 1982.3 |
| 632 | 399424 | 252435968 | 25.1396 | 8.5817 | 2.80072 | 1.58228 | 1985.5 |
| 633 | 400689 | 253636137 | 25.1595 | 8.5862 | 2.80140 | 1.57978 | 1988.6 |
| 634 | 401956 | 254840104 | 25.1794 | 8.5907 | 2.80209 | 1.57729 | 1991.8 |
| 635 | 403225 | 256047875 | 25.1992 | 8.5952 | 2.80277 | 1.57480 | 1994.9 |
| 636 | 404496 | 257259456 | 25.2190 | 8.5997 | 2.80346 | 1.57233 | 1998.1 |
| 637 | 405769 | 258474853 | 25.2389 | 8.6043 | 2.80414 | 1.56986 | 2001.2 |
| 638 | 407044 | 259694072 | 25.2587 | 8.6088 | 2.80482 | 1.56740 | 2004.3 |
| 639 | 408321 | 260917119 | 25.2784 | 8.6132 | 2.80550 | 1.56495 | 2007.5 |
| 640 | 409600 | 262144000 | 25.2982 | 8.6177 | 2.80618 | 1.56250 | 2010.6 |
| 641 | 410881 | 263374721 | 25.3180 | 8.6222 | 2.80686 | 1.56006 | 2013.8 |
| 642 | 412164 | 264609288 | 25.3377 | 8.6267 | 2.80754 | 1.55763 | 2016.9 |
| 643 | 413449 | 265847707 | 25.3574 | 8.6312 | 2.80821 | 1.55521 | 2020.0 |
| 644 | 414736 | 267089984 | 25.3772 | 8.6357 | 2.80889 | 1.55280 | 2023.2 |
| 645 | 416025 | 268336125 | 25.3969 | 8.6401 | 2.80956 | 1.55039 | 2026.3 |
| 646 | 417316 | 269586136 | 25.4165 | 8.6446 | 2.81023 | 1.54799 | 2029.5 |
| 647 | 418609 | 270840023 | 25.4362 | 8.6490 | 2.81090 | 1.54560 | 2032.6 |
| 648 | 419904 | 272097792 | 25.4558 | 8.6535 | 2.81158 | 1.54321 | 2035.8 |
| 649 | 421201 | 273359449 | 25.4755 | 8.6579 | 2.81224 | 1.54083 | 2038.9 |

# Functions of Numbers, 650 to 699

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 650 | 422500 | 274625000 | 25.4951 | 8.6624 | 2.81291 | 1.53846 | 2042.0 | 331831 |
| 651 | 423801 | 275894451 | 25.5147 | 8.6668 | 2.81358 | 1.53610 | 2045.2 | 332853 |
| 652 | 425104 | 277167808 | 25.5343 | 8.6713 | 2.81425 | 1.53374 | 2048.3 | 333876 |
| 653 | 426409 | 278445077 | 25.5539 | 8.6757 | 2.81491 | 1.53139 | 2051.5 | 334901 |
| 654 | 427716 | 279726264 | 25.5734 | 8.6801 | 2.81558 | 1.52905 | 2054.6 | 335927 |
| 655 | 429025 | 281011375 | 25.5930 | 8.6845 | 2.81624 | 1.52672 | 2057.7 | 336955 |
| 656 | 430336 | 282300416 | 25.6125 | 8.6890 | 2.81690 | 1.52439 | 2060.9 | 337985 |
| 657 | 431649 | 283593393 | 25.6320 | 8.6934 | 2.81757 | 1.52207 | 2064.0 | 339016 |
| 658 | 432964 | 284890312 | 25.6515 | 8.6978 | 2.81823 | 1.51976 | 2067.2 | 340049 |
| 659 | 434281 | 286191179 | 25.6710 | 8.7022 | 2.81889 | 1.51745 | 2070.3 | 341084 |
| 660 | 435600 | 287496000 | 25.6905 | 8.7066 | 2.81954 | 1.51515 | 2073.5 | 342119 |
| 661 | 436921 | 288804781 | 25.7099 | 8.7110 | 2.82020 | 1.51286 | 2076.6 | 343157 |
| 662 | 438244 | 290117528 | 25.7294 | 8.7154 | 2.82086 | 1.51057 | 2079.7 | 344196 |
| 663 | 439569 | 291434247 | 25.7488 | 8.7198 | 2.82151 | 1.50830 | 2082.9 | 345237 |
| 664 | 440896 | 292754944 | 25.7682 | 8.7241 | 2.82217 | 1.50602 | 2086.0 | 346279 |
| 665 | 442225 | 294079625 | 25.7876 | 8.7285 | 2.82282 | 1.50376 | 2089.2 | 347323 |
| 666 | 443556 | 295408296 | 25.8070 | 8.7329 | 2.82347 | 1.50150 | 2092.3 | 348368 |
| 667 | 444889 | 296740963 | 25.8263 | 8.7373 | 2.82413 | 1.49925 | 2095.4 | 349415 |
| 668 | 446224 | 298077632 | 25.8457 | 8.7416 | 2.82478 | 1.49701 | 2098.6 | 350464 |
| 669 | 447561 | 299418309 | 25.8650 | 8.7460 | 2.82543 | 1.49477 | 2101.7 | 351514 |
| 670 | 448900 | 300763000 | 25.8844 | 8.7503 | 2.82607 | 1.49254 | 2104.9 | 352565 |
| 671 | 450241 | 302111711 | 25.9037 | 8.7547 | 2.82672 | 1.49031 | 2108.0 | 353618 |
| 672 | 451584 | 303464448 | 25.9230 | 8.7590 | 2.82737 | 1.48810 | 2111.2 | 354673 |
| 673 | 452929 | 304821217 | 25.9422 | 8.7634 | 2.82082 | 1.48588 | 2114.3 | 355730 |
| 674 | 454276 | 306182024 | 25.9615 | 8.7677 | 2.82866 | 1.48368 | 2117.4 | 356788 |
| 675 | 455625 | 307546875 | 25.9808 | 8.7721 | 2.82930 | 1.48148 | 2120.6 | 357847 |
| 676 | 456976 | 308915776 | 26.0000 | 8.7764 | 2.82995 | 1.47929 | 2123.7 | 358908 |
| 677 | 458329 | 310288733 | 26.0192 | 8.7807 | 2.83059 | 1.47710 | 2126.9 | 359971 |
| 678 | 459684 | 311665752 | 26.0384 | 8.7850 | 2.83123 | 1.47493 | 2130.0 | 361035 |
| 679 | 461041 | 313046839 | 26.0576 | 8.7893 | 2.83187 | 1.47275 | 2133.1 | 362101 |
| 680 | 462400 | 314432000 | 26.0768 | 8.7937 | 2.83251 | 1.47059 | 2136.3 | 363168 |
| 681 | 463761 | 315821241 | 26.0960 | 8.7980 | 2.83315 | 1.46843 | 2139.4 | 364237 |
| 682 | 465124 | 317214568 | 26.1151 | 8.8023 | 2.83378 | 1.46628 | 2142.6 | 365308 |
| 683 | 456489 | 318611987 | 26.1342 | 8.3066 | 2.83442 | 1.46413 | 2145.7 | 366380 |
| 684 | 467856 | 320013504 | 26.1534 | 8.8109 | 2.83506 | 1.46199 | 2148.8 | 367453 |
| 685 | 469225 | 321419125 | 26.1725 | 8.8152 | 2.83569 | 1.45985 | 2152.0 | 368528 |
| 686 | 470596 | 322828856 | 26.1916 | 8.8194 | 2.83632 | 1.45773 | 2155.1 | 369605 |
| 687 | 471969 | 324242703 | 26.2107 | 8.8237 | 2.83696 | 1.45560 | 2158.3 | 370684 |
| 688 | 473344 | 325660672 | 26.2298 | 8.8280 | 2.83759 | 1.45349 | 2161.4 | 371764 |
| 689 | 474721 | 327082769 | 26.2488 | 8.8323 | 2.83822 | 1.45138 | 2164.6 | 372845 |
| 690 | 476100 | 328509000 | 26.2679 | 8.8366 | 2.83885 | 1.44928 | 2167.7 | 373928 |
| 691 | 477481 | 329939371 | 26.2869 | 8.8408 | 2.83948 | 1.44718 | 2170.8 | 375013 |
| 692 | 478864 | 331373888 | 26.3059 | 8.8451 | 2.84011 | 1.44509 | 2174.0 | 376099 |
| 693 | 480249 | 332812557 | 26.3249 | 8.8493 | 2.84073 | 1.44300 | 2177.1 | 377187 |
| 694 | 481636 | 334255384 | 26.3439 | 8.8536 | 2.84136 | 1.44092 | 2180.3 | 378276 |
| 695 | 483025 | 335702375 | 26.3629 | 8.8578 | 2.84198 | 1.43885 | 2183.4 | 379367 |
| 696 | 484416 | 337153536 | 26.3818 | 8.8621 | 2.84261 | 1.43678 | 2186.5 | 380459 |
| 697 | 485809 | 338608873 | 26.4008 | 8.8663 | 2.84323 | 1.43472 | 2189.7 | 381553 |
| 698 | 487204 | 340068392 | 26.4197 | 8.8706 | 2.84386 | 1.43266 | 2192.8 | 382649 |
| 699 | 488601 | 341532099 | 26.4386 | 8.8748 | 2.84448 | 1.43062 | 2196.0 | 383746 |

# Functions of Numbers, 700 to 749

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter Circum. | No. = Diameter Area |
|---|---|---|---|---|---|---|---|---|
| 700 | 490000 | 343000000 | 26.4575 | 8.8790 | 2.84510 | 1.42857 | 2199.1 | 384845 |
| 701 | 491401 | 344472101 | 26.4764 | 8.8833 | 2.84572 | 1.42653 | 2202.3 | 385945 |
| 702 | 492804 | 345948408 | 26.4953 | 8.8875 | 2.84634 | 1.42450 | 2205.4 | 387047 |
| 703 | 494209 | 347428927 | 26.5141 | 8.8917 | 2.84696 | 1.42248 | 2208.5 | 388151 |
| 704 | 495616 | 348913664 | 26.5330 | 8.8959 | 2.84757 | 1.42045 | 2211.7 | 389256 |
| 705 | 497025 | 350402625 | 26.5518 | 8.9001 | 2.84819 | 1.41844 | 2214.8 | 390363 |
| 706 | 498436 | 351895816 | 26.5707 | 8.9043 | 2.84880 | 1.41643 | 2218.0 | 391471 |
| 707 | 499849 | 353393243 | 26.5895 | 8.9085 | 2.84942 | 1.41443 | 2221.1 | 392580 |
| 708 | 501264 | 354894912 | 26.6083 | 8.9127 | 2.85003 | 1.41243 | 2224.2 | 393692 |
| 709 | 502681 | 356400829 | 26.6271 | 8.9169 | 2.85065 | 1.41044 | 2227.4 | 394805 |
| 710 | 504100 | 357911000 | 26.6458 | 8.9211 | 2.85126 | 1.40845 | 2230.5 | 395919 |
| 711 | 505521 | 359425431 | 26.6646 | 8.9253 | 2.85187 | 1.40647 | 2233.7 | 397035 |
| 712 | 506944 | 360944128 | 26.6833 | 8.9295 | 2.85248 | 1.40449 | 2236.8 | 398153 |
| 713 | 508369 | 362467097 | 26.7021 | 8.9337 | 2.85309 | 1.40252 | 2240.0 | 399272 |
| 714 | 509796 | 363994344 | 26.7208 | 8.9378 | 2.85370 | 1.40056 | 2243.1 | 400393 |
| 715 | 511225 | 365525875 | 26.7395 | 8.9420 | 2.85431 | 1.39860 | 2246.2 | 401515 |
| 716 | 512656 | 367061696 | 26.7582 | 8.9462 | 2.85491 | 1.39665 | 2249.4 | 402639 |
| 717 | 514089 | 368601813 | 26.7769 | 8.9503 | 2.85552 | 1.39470 | 2252.5 | 403765 |
| 718 | 515524 | 370146232 | 26.7955 | 8.9545 | 2.85612 | 1.39276 | 2255.7 | 404892 |
| 719 | 516961 | 371694959 | 26.8142 | 8.9587 | 2.85673 | 1.39082 | 2258.8 | 406020 |
| 720 | 518400 | 373248000 | 26.8328 | 8.9628 | 2.85733 | 1.38889 | 2261.9 | 407150 |
| 721 | 519841 | 374805361 | 26.8514 | 8.9670 | 2.85794 | 1.38696 | 2265.1 | 408282 |
| 722 | 521284 | 376367048 | 26.8701 | 8.9711 | 2.85854 | 1.38504 | 2268.2 | 409415 |
| 723 | 522729 | 377933067 | 26.8887 | 8.9752 | 2.85914 | 1.38313 | 2271.4 | 410550 |
| 724 | 524176 | 379503424 | 26.9072 | 8.9794 | 2.85974 | 1.38122 | 2274.5 | 411687 |
| 725 | 525625 | 381078125 | 26.9258 | 8.9835 | 2.86034 | 1.37931 | 2277.7 | 412825 |
| 726 | 527076 | 382657176 | 26.9444 | 8.9876 | 2.86094 | 1.37741 | 2280.8 | 413965 |
| 727 | 528529 | 384240583 | 26.9629 | 8.9918 | 2.86153 | 1.37552 | 2283.9 | 415106 |
| 728 | 529984 | 385828352 | 26.9815 | 8.9959 | 2.86213 | 1.37363 | 2287.1 | 416248 |
| 729 | 531441 | 387420489 | 27.0000 | 9.0000 | 2.86273 | 1.37174 | 2290.2 | 417393 |
| 730 | 532900 | 389017000 | 27.0185 | 9.0041 | 2.86332 | 1.36986 | 2293.4 | 418539 |
| 731 | 534361 | 390617891 | 27.0370 | 9.0082 | 2.86392 | 1.36799 | 2296.5 | 419686 |
| 732 | 535824 | 392223168 | 27.0555 | 9.0123 | 2.86451 | 1.36612 | 2299.6 | 420835 |
| 733 | 537289 | 393832837 | 27.0740 | 9.0164 | 2.86510 | 1.36426 | 2302.8 | 421986 |
| 734 | 538756 | 395446904 | 27.0924 | 9.0205 | 2.86570 | 1.36240 | 2305.9 | 423138 |
| 735 | 540225 | 397065375 | 27.1109 | 9.0246 | 2.86629 | 1.36054 | 2309.1 | 424293 |
| 736 | 541696 | 398688256 | 27.1293 | 9.0287 | 2.86688 | 1.35870 | 2312.2 | 425447 |
| 737 | 543169 | 400315553 | 27.1477 | 9.0328 | 2.86747 | 1.35685 | 2315.4 | 426604 |
| 738 | 544644 | 401947272 | 27.1662 | 9.0369 | 2.86806 | 1.35501 | 2318.5 | 427762 |
| 739 | 546121 | 403583419 | 27.1846 | 9.0410 | 2.86864 | 1.35318 | 2321.6 | 428922 |
| 740 | 547600 | 405224000 | 27.2029 | 9.0450 | 2.86923 | 1.35135 | 2324.8 | 430084 |
| 741 | 549081 | 406869021 | 27.2213 | 9.0491 | 2.86982 | 1.34953 | 2327.9 | 431247 |
| 742 | 550564 | 408518488 | 27.2397 | 9.0532 | 2.87040 | 1.34771 | 2331.1 | 432412 |
| 743 | 552049 | 410172407 | 27.2580 | 9.0572 | 2.87099 | 1.34590 | 2334.2 | 433578 |
| 744 | 553536 | 411830784 | 27.2764 | 9.0613 | 2.87157 | 1.34409 | 2337.3 | 434746 |
| 745 | 555025 | 413493625 | 27.2947 | 9.0654 | 2.87216 | 1.34228 | 2340.5 | 435916 |
| 746 | 556516 | 415160936 | 27.3130 | 9.0694 | 2.87274 | 1.34048 | 2343.6 | 437087 |
| 747 | 558009 | 416832723 | 27.3313 | 9.0735 | 2.87332 | 1.33869 | 2346.8 | 438259 |
| 748 | 559504 | 418508992 | 27.3496 | 9.0775 | 2.87390 | 1.33690 | 2349.9 | 439433 |
| 749 | 561001 | 420189749 | 27.3679 | 9.0816 | 2.87448 | 1.33511 | 2353.1 | 440609 |

# Functions of Numbers, 750 to 799

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter Circum. | Area |
|---|---|---|---|---|---|---|---|---|
| 750 | 562500 | 421875000 | 27.3861 | 9.0856 | 2.87506 | 1.33333 | 2356.2 | 441786 |
| 751 | 564001 | 423564751 | 27.4044 | 9.0896 | 2.87564 | 1.33156 | 2359.3 | 442965 |
| 752 | 565504 | 425259008 | 27.4226 | 9.0937 | 2.87622 | 1.32979 | 2362.5 | 444146 |
| 753 | 567009 | 426957777 | 27.4408 | 9.0977 | 2.87680 | 1.32802 | 2365.6 | 445328 |
| 754 | 568516 | 428661064 | 27.4591 | 9.1017 | 2.87737 | 1.32626 | 2368.8 | 446511 |
| 755 | 570025 | 430368875 | 27.4773 | 9.1057 | 2.87795 | 1.32450 | 2371.9 | 447697 |
| 756 | 571536 | 432081216 | 27.4955 | 9.1098 | 2.87852 | 1.32275 | 2375.0 | 448883 |
| 757 | 573049 | 433798093 | 27.5136 | 9.1138 | 2.87910 | 1.32100 | 2378.2 | 450072 |
| 758 | 574564 | 435519512 | 27.5318 | 9.1178 | 2.87967 | 1.31926 | 2381.3 | 451262 |
| 759 | 576081 | 437245479 | 27.5500 | 9.1218 | 2.88024 | 1.31752 | 2384.5 | 452453 |
| 760 | 577600 | 438976000 | 27.5681 | 9.1258 | 2.88081 | 1.31579 | 2387.6 | 453646 |
| 761 | 579121 | 440711081 | 27.5862 | 9.1298 | 2.88138 | 1.31406 | 2390.8 | 454841 |
| 762 | 580644 | 442450728 | 27.6043 | 9.1338 | 2.88196 | 1.31234 | 2393.9 | 456037 |
| 763 | 582169 | 444194947 | 27.6225 | 9.1378 | 2.88252 | 1.31062 | 2397.0 | 457234 |
| 764 | 583696 | 445943744 | 27.6405 | 9.1418 | 2.88309 | 1.30890 | 2400.2 | 458434 |
| 765 | 585225 | 447697125 | 27.6586 | 9.1458 | 2.88366 | 1.30719 | 2403.3 | 459635 |
| 766 | 586756 | 449455096 | 27.6767 | 9.1498 | 2.88423 | 1.30548 | 2406.5 | 460837 |
| 767 | 588289 | 451217663 | 27.6948 | 9.1537 | 2.88480 | 1.30378 | 2409.6 | 462041 |
| 768 | 589824 | 452984832 | 27.7128 | 9.1577 | 2.88536 | 1.30208 | 2412.7 | 463247 |
| 769 | 591361 | 454756609 | 27.7308 | 9.1617 | 2.88593 | 1.30039 | 2415.9 | 464454 |
| 770 | 592900 | 456533000 | 27.7489 | 9.1657 | 2.88649 | 1.29870 | 2419.0 | 465663 |
| 771 | 594441 | 458314011 | 27.7669 | 9.1696 | 2.88705 | 1.29702 | 2422.2 | 466873 |
| 772 | 595984 | 460099648 | 27.7849 | 9.1736 | 2.88762 | 1.29534 | 2425.3 | 468085 |
| 773 | 597529 | 461889917 | 27.8029 | 9.1775 | 2.88818 | 1.29366 | 2428.5 | 469298 |
| 774 | 599076 | 463684824 | 27.8209 | 9.1815 | 2.88874 | 1.29199 | 2431.6 | 470513 |
| 775 | 600625 | 465484375 | 27.8388 | 9.1855 | 2.88930 | 1.29032 | 2434.7 | 471730 |
| 776 | 602176 | 467288576 | 27.8568 | 9.1894 | 2.88986 | 1.28866 | 2437.9 | 472948 |
| 777 | 603729 | 469097433 | 27.8747 | 9.1933 | 2.89042 | 1.28700 | 2441.0 | 474168 |
| 778 | 605284 | 470910952 | 27.8927 | 9.1973 | 2.89098 | 1.28535 | 2444.2 | 475389 |
| 779 | 606841 | 472729139 | 27.9106 | 9.2012 | 2.89154 | 1.28370 | 2447.3 | 476612 |
| 780 | 608400 | 474552000 | 27.9285 | 9.2052 | 2.89209 | 1.28205 | 2450.4 | 477836 |
| 781 | 609961 | 476379541 | 27.9464 | 9.2091 | 2.89265 | 1.28041 | 2453.6 | 479062 |
| 782 | 611524 | 478211768 | 27.9643 | 9.2130 | 2.89321 | 1.27877 | 2456.7 | 480290 |
| 783 | 613089 | 480048687 | 27.9821 | 9.2170 | 2.89376 | 1.27714 | 2459.9 | 481519 |
| 784 | 614656 | 481890304 | 28.0000 | 9.2209 | 2.89432 | 1.27551 | 2463.0 | 482750 |
| 785 | 616225 | 483736625 | 28.0179 | 9.2248 | 2.89487 | 1.27389 | 2466.2 | 483982 |
| 786 | 617796 | 485587656 | 28.0357 | 9.2287 | 2.89542 | 1.27226 | 2469.3 | 485216 |
| 787 | 619369 | 487443403 | 28.0535 | 9.2326 | 2.89597 | 1.27065 | 2472.4 | 486451 |
| 788 | 620944 | 489303872 | 28.0713 | 9.2365 | 2.89653 | 1.26904 | 2475.6 | 487688 |
| 789 | 622521 | 491169069 | 28.0891 | 9.2404 | 2.89708 | 1.26743 | 2478.7 | 488927 |
| 790 | 624100 | 493039000 | 28.1069 | 9.2443 | 2.89763 | 1.26582 | 2481.9 | 490167 |
| 791 | 625681 | 494913671 | 28.1247 | 9.2482 | 2.89818 | 1.26422 | 2485.0 | 491409 |
| 792 | 627264 | 496793088 | 28.1425 | 9.2521 | 2.89873 | 1.26263 | 2488.1 | 492652 |
| 793 | 628849 | 498677257 | 28.1603 | 9.2560 | 2.89927 | 1.26103 | 2491.3 | 493897 |
| 794 | 630436 | 500566184 | 28.1780 | 9.2599 | 2.89982 | 1.25945 | 2494.4 | 495143 |
| 795 | 632025 | 502459875 | 28.1957 | 9.2638 | 2.90037 | 1.25786 | 2497.6 | 496391 |
| 796 | 633616 | 504358336 | 28.2135 | 9.2677 | 2.90091 | 1.25628 | 2500.7 | 497641 |
| 797 | 635209 | 506261573 | 23.2312 | 9.2716 | 2.90146 | 1.25471 | 2503.8 | 498892 |
| 798 | 636804 | 508169592 | 28.2489 | 9.2754 | 2.90200 | 1.25313 | 2507.0 | 500145 |
| 799 | 638401 | 510082399 | 28.2666 | 9.2793 | 2.90255 | 1.25156 | 2510.1 | 501399 |

# Functions of Numbers, 800 to 849

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diamete | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Are |
| 800 | 640000 | 512000000 | 28.2843 | 9.2832 | 2.90309 | 1.25000 | 2513.3 | 5026 |
| 801 | 641601 | 513922401 | 28.3019 | 9.2870 | 2.90363 | 1.24844 | 2516.4 | 5039 |
| 802 | 643204 | 515849608 | 28.3196 | 9.2909 | 2.90417 | 1.24688 | 2519.6 | 5051 |
| 803 | 644809 | 517781627 | 28.3373 | 9.2948 | 2.90472 | 1.24533 | 2522.7 | 5064 |
| 804 | 646416 | 519718464 | 28.3549 | 9.2986 | 2.90526 | 1.24378 | 2525.8 | 5076 |
| 805 | 648025 | 521660125 | 28.3725 | 9.3025 | 2.90580 | 1.24224 | 2529.0 | 5089 |
| 806 | 649636 | 523606616 | 28.3901 | 9.3063 | 2.90634 | 1.24069 | 2532.1 | 5102 |
| 807 | 651249 | 525557943 | 28.4077 | 9.3102 | 2.90687 | 1.23916 | 2535.3 | 5114 |
| 808 | 652864 | 527514112 | 28.4253 | 9.3140 | 2.90741 | 1.23762 | 2538.4 | 5127 |
| 809 | 654481 | 529475129 | 28.4429 | 9.3179 | 2.90795 | 1.23609 | 2541.5 | 5140 |
| 810 | 656100 | 531441000 | 28.4605 | 9.3217 | 2.90849 | 1.23457 | 2544.7 | 5153 |
| 811 | 657721 | 533411731 | 28.4781 | 9.3255 | 2.90902 | 1.23305 | 2547.8 | 5165 |
| 812 | 659344 | 535387328 | 28.4956 | 9.3294 | 2.90956 | 1.23153 | 2551.0 | 5178 |
| 813 | 660969 | 537367797 | 28.5132 | 9.3332 | 2.91009 | 1.23001 | 2554.1 | 5191 |
| 814 | 662596 | 539353144 | 28.5307 | 9.3370 | 2.91062 | 1.22850 | 2557.3 | 5204 |
| 815 | 664225 | 541343375 | 28.5482 | 9.3408 | 2.91116 | 1.22699 | 2560.4 | 5216 |
| 816 | 665856 | 543338496 | 28.5657 | 9.3447 | 2.91169 | 1.22549 | 2563.5 | 5229 |
| 817 | 667489 | 545338513 | 28.5832 | 9.3485 | 2.91222 | 1.22399 | 2566.7 | 5242 |
| 818 | 669124 | 547343432 | 28.6007 | 9.3523 | 2.91275 | 1.22249 | 2569.8 | 5255 |
| 819 | 670761 | 549353259 | 28.6182 | 9.3561 | 2.91328 | 1.22100 | 2573.0 | 5268 |
| 820 | 672400 | 551368000 | 28.6356 | 9.3599 | 2.91381 | 1.21951 | 2576.1 | 5281 |
| 821 | 674041 | 553387661 | 28.6531 | 9.3637 | 2.91434 | 1.21803 | 2579.2 | 5293 |
| 822 | 675684 | 555412248 | 28.6705 | 9.3675 | 2.91487 | 1.21655 | 2582.4 | 5306 |
| 823 | 677329 | 557441767 | 28.6880 | 9.3713 | 2.91540 | 1.21507 | 2585.5 | 5319 |
| 824 | 678976 | 559476224 | 28.7054 | 9.3751 | 2.91593 | 1.21359 | 2588.7 | 5332 |
| 825 | 680625 | 561515625 | 28.7228 | 9.3789 | 2.91645 | 1.21212 | 2591.8 | 5345 |
| 826 | 682276 | 563559976 | 28.7402 | 9.3827 | 2.91698 | 1.21065 | 2595.0 | 5358 |
| 827 | 683929 | 565609283 | 28.7576 | 9.3865 | 2.91751 | 1.20919 | 2598.1 | 5371 |
| 828 | 685584 | 567663552 | 28.7750 | 9.3902 | 2.91803 | 1.20773 | 2601.2 | 5384 |
| 829 | 687241 | 569722789 | 28.7924 | 9.3940 | 2.91855 | 1.20627 | 2604.4 | 5397 |
| 830 | 688900 | 571787000 | 28.8097 | 9.3978 | 2.91908 | 1.20482 | 2607.5 | 5410 |
| 831 | 690561 | 573856191 | 28.8271 | 9.4016 | 2.91960 | 1.20337 | 2610.7 | 5423 |
| 832 | 692224 | 575930368 | 28.8444 | 9.4053 | 2.92012 | 1.20192 | 2613.8 | 5436 |
| 833 | 693889 | 578009537 | 28.8617 | 9.4091 | 2.92065 | 1.20048 | 2616.9 | 5449 |
| 834 | 695556 | 580093704 | 28.8791 | 9.4129 | 2.92117 | 1.19904 | 2620.1 | 5462 |
| 835 | 697225 | 582182875 | 28.8964 | 9.4166 | 2.92169 | 1.19760 | 2623.2 | 5475 |
| 836 | 698896 | 584277056 | 28.9137 | 9.4204 | 2.92221 | 1.19617 | 2626.4 | 5489 |
| 837 | 700569 | 586376253 | 28.9310 | 9.4241 | 2.92273 | 1.19474 | 2629.5 | 5502 |
| 838 | 702244 | 588480472 | 28.9482 | 9.4279 | 2.92324 | 1.19332 | 2632.7 | 5515 |
| 839 | 703921 | 590589719 | 28.9655 | 9.4316 | 2.92376 | 1.19190 | 2635.8 | 5528 |
| 840 | 705600 | 592704000 | 28.9828 | 9.4354 | 2.92428 | 1.19048 | 2638.9 | 5541 |
| 841 | 707281 | 594823321 | 29.0000 | 9.4391 | 2.92480 | 1.18906 | 2642.1 | 5554 |
| 842 | 708964 | 596947688 | 29.0172 | 9.4429 | 2.92531 | 1.18765 | 2645.2 | 5568 |
| 843 | 710649 | 599077107 | 29.0345 | 9.4466 | 2.92583 | 1.18624 | 2648.4 | 5581 |
| 844 | 712336 | 601211584 | 29.0517 | 9.4503 | 2.92634 | 1.18483 | 2651.5 | 5594 |
| 845 | 714025 | 603351125 | 29.0689 | 9.4541 | 2.92686 | 1.18343 | 2654.6 | 5607 |
| 846 | 715716 | 605495736 | 29.0861 | 9.4578 | 2.92737 | 1.18203 | 2657.8 | 5621 |
| 847 | 717409 | 607645423 | 29.1033 | 9.4615 | 2.92788 | 1.18064 | 2660.9 | 5634 |
| 848 | 719104 | 609800192 | 29.1204 | 9.4652 | 2.92840 | 1.17925 | 2664.1 | 5647 |
| 849 | 720801 | 611960049 | 29.1376 | 9.4690 | 2.92891 | 1.17786 | 2667.2 | 5661 |

# Functions of Numbers, 850 to 899

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 850 | 722500 | 614125000 | 29.1548 | 9.4727 | 2.92942 | 1.17647 | 2670.4 | 567450 |
| 851 | 724201 | 616295051 | 29.1719 | 9.4764 | 2.92993 | 1.17509 | 2673.5 | 568786 |
| 852 | 725904 | 618470208 | 29.1890 | 9.4801 | 2.93044 | 1.17371 | 2676.6 | 570124 |
| 853 | 727609 | 620650477 | 29.2062 | 9.4838 | 2.93095 | 1.17233 | 2679.8 | 571463 |
| 854 | 729316 | 622835864 | 29.2233 | 9.4875 | 2.93146 | 1.17096 | 2682.9 | 572803 |
| 855 | 731025 | 625026375 | 29.2404 | 9.4912 | 2.93197 | 1.16959 | 2686.1 | 574146 |
| 856 | 732736 | 627222016 | 29.2575 | 9.4949 | 2.93247 | 1.16822 | 2689.2 | 575490 |
| 857 | 734449 | 629422793 | 29.2746 | 9.4986 | 2.93298 | 1.16686 | 2692.3 | 576835 |
| 858 | 736164 | 631628712 | 29.2916 | 9.5023 | 2.93349 | 1.16550 | 2695.5 | 578182 |
| 859 | 737881 | 633839779 | 29.3087 | 9.5060 | 2.93399 | 1.16414 | 2698.6 | 579530 |
| 860 | 739600 | 636056000 | 29.3258 | 9.5097 | 2.93450 | 1.16279 | 2701.8 | 580880 |
| 861 | 741321 | 638277381 | 29.3428 | 9.5134 | 2.93500 | 1.16144 | 2704.9 | 582232 |
| 862 | 743044 | 640503928 | 29.3598 | 9.5171 | 2.93551 | 1.16009 | 2708.1 | 583585 |
| 863 | 744769 | 642735647 | 29.3769 | 9.5207 | 2.93601 | 1.15875 | 2711.2 | 584940 |
| 864 | 746496 | 644972544 | 29.3939 | 9.5244 | 2.93651 | 1.15741 | 2714.3 | 586297 |
| 865 | 748225 | 647214625 | 29.4109 | 9.5281 | 2.93702 | 1.15607 | 2717.5 | 587655 |
| 866 | 749956 | 649461896 | 29.4279 | 9.5317 | 2.93752 | 1.15473 | 2720.6 | 589014 |
| 867 | 751689 | 651714363 | 29.4449 | 9.5354 | 2.93802 | 1.15340 | 2723.8 | 590375 |
| 868 | 753424 | 653972032 | 29.4618 | 9.5391 | 2.93852 | 1.15207 | 2726.9 | 591738 |
| 869 | 755161 | 656234909 | 29.4788 | 9.5427 | 2.93902 | 1.15075 | 2730.0 | 593102 |
| 870 | 756900 | 658503000 | 29.4958 | 9.5464 | 2.93952 | 1.14943 | 2733.2 | 594468 |
| 871 | 758641 | 660776311 | 29.5127 | 9.5501 | 2.94002 | 1.14811 | 2736.3 | 595835 |
| 872 | 760384 | 663054848 | 29.5296 | 9.5537 | 2.94052 | 1.14679 | 2739.5 | 597204 |
| 873 | 762129 | 665338617 | 29.5466 | 9.5574 | 2.94101 | 1.14548 | 2742.6 | 598575 |
| 874 | 763876 | 667627624 | 29.5635 | 9.5610 | 2.94151 | 1.14416 | 2745.8 | 599947 |
| 875 | 765625 | 669921875 | 29.5804 | 9.5647 | 2.94201 | 1.14286 | 2748.9 | 601320 |
| 876 | 767376 | 672221376 | 29.5973 | 9.5683 | 2.94250 | 1.14155 | 2752.0 | 602696 |
| 877 | 769129 | 674526133 | 29.6142 | 9.5719 | 2.94300 | 1.14025 | 2755.2 | 604073 |
| 878 | 770884 | 676836152 | 29.6311 | 9.5756 | 2.94349 | 1.13895 | 2758.3 | 605451 |
| 879 | 772641 | 679151439 | 29.6479 | 9.5792 | 2.94399 | 1.13766 | 2761.5 | 606831 |
| 880 | 774400 | 681472000 | 29.6648 | 9.5828 | 2.94448 | 1.13636 | 2764.6 | 608212 |
| 881 | 776161 | 683797841 | 29.6816 | 9.5865 | 2.94498 | 1.13507 | 2767.7 | 609595 |
| 882 | 777924 | 686128968 | 29.6985 | 9.5901 | 2.94547 | 1.13379 | 2770.9 | 610980 |
| 883 | 779689 | 688465387 | 29.7153 | 9.5937 | 2.94596 | 1.13250 | 2774.0 | 612366 |
| 884 | 781456 | 690807104 | 29.7321 | 9.5973 | 2.94645 | 1.13122 | 2777.2 | 613754 |
| 885 | 783225 | 693154125 | 29.7489 | 9.6010 | 2.94694 | 1.12994 | 2780.3 | 615143 |
| 886 | 784996 | 695506456 | 29.7658 | 9.6046 | 2.94743 | 1.12867 | 2783.5 | 616534 |
| 887 | 786769 | 697864103 | 29.7825 | 9.6082 | 2.94792 | 1.12740 | 2786.6 | 617927 |
| 888 | 788544 | 700227072 | 29.7993 | 9.6118 | 2.94841 | 1.12613 | 2789.7 | 619321 |
| 889 | 790321 | 702595369 | 29.8161 | 9.6154 | 2.94890 | 1.12486 | 2792.9 | 620717 |
| 890 | 792100 | 704969000 | 29.8329 | 9.6190 | 2.94939 | 1.12360 | 2796.0 | 622114 |
| 891 | 793881 | 707347971 | 29.8496 | 9.6226 | 2.94988 | 1.12233 | 2799.2 | 623513 |
| 892 | 795664 | 709732288 | 29.8664 | 9.6262 | 2.95036 | 1.12108 | 2802.3 | 624913 |
| 893 | 797449 | 712121957 | 29.8831 | 9.6298 | 2.95085 | 1.11982 | 2805.4 | 626315 |
| 894 | 799236 | 714516984 | 29.8998 | 9.6334 | 2.95134 | 1.11857 | 2808.6 | 627718 |
| 895 | 801025 | 716917375 | 29.9166 | 9.6370 | 2.95182 | 1.11732 | 2811.7 | 629124 |
| 896 | 802816 | 719323136 | 29.9333 | 9.6406 | 2.95231 | 1.11607 | 2814.9 | 630530 |
| 897 | 804609 | 721734273 | 29.9500 | 9.6442 | 2.95279 | 1.11483 | 2818.0 | 631938 |
| 898 | 806404 | 724150792 | 29.9666 | 9.6477 | 2.95328 | 1.11359 | 2821.2 | 633348 |
| 899 | 808201 | 726572699 | 29.9833 | 9.6513 | 2.95376 | 1.11235 | 2824.3 | 634760 |

# Functions of Numbers, 900 to 949

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 900 | 810000 | 729000000 | 30.0000 | 9.6549 | 2.95424 | 1.11111 | 2827.4 | 636173 |
| 901 | 811801 | 731432701 | 30.0167 | 9.6585 | 2.95472 | 1.10988 | 2830.6 | 637587 |
| 902 | 813604 | 733870808 | 30.0333 | 9.6620 | 2.95521 | 1.10865 | 2833.7 | 639003 |
| 903 | 815409 | 736314327 | 30.0500 | 9.6656 | 2.95569 | 1.10742 | 2836.9 | 640421 |
| 904 | 817216 | 738763264 | 30.0666 | 9.6692 | 2.95617 | 1.10619 | 2840.0 | 641840 |
| 905 | 819025 | 741217625 | 30.0832 | 9.6727 | 2.95665 | 1.10497 | 2843.1 | 643261 |
| 906 | 820836 | 743677416 | 30.0998 | 9.6763 | 2.95713 | 1.10375 | 2846.3 | 644683 |
| 907 | 822649 | 746142643 | 30.1164 | 9.6799 | 2.95761 | 1.10254 | 2849.4 | 646107 |
| 908 | 824464 | 748613312 | 30.1330 | 9.6834 | 2.95809 | 1.10132 | 2852.6 | 647533 |
| 909 | 826281 | 751089429 | 30.1496 | 9.6870 | 2.95856 | 1.10011 | 2855.7 | 648960 |
| 910 | 828100 | 753571000 | 30.1662 | 9.6905 | 2.95904 | 1.09890 | 2858.8 | 650388 |
| 911 | 829921 | 756058031 | 30.1828 | 9.6941 | 2.95952 | 1.09769 | 2862.0 | 651818 |
| 912 | 831744 | 758550528 | 30.1993 | 9.6976 | 2.95999 | 1.09649 | 2865.1 | 653250 |
| 913 | 833569 | 761048497 | 30.2159 | 9.7012 | 2.96047 | 1.09529 | 2868.3 | 654684 |
| 914 | 835396 | 763551944 | 30.2324 | 9.7047 | 2.96095 | 1.09409 | 2871.4 | 656118 |
| 915 | 837225 | 766060875 | 30.2490 | 9.7082 | 2.96142 | 1.09290 | 2874.6 | 657555 |
| 916 | 839056 | 768575296 | 30.2655 | 9.7118 | 2.96190 | 1.09170 | 2877.7 | 658993 |
| 917 | 840889 | 771095213 | 30.2820 | 9.7153 | 2.96237 | 1.09051 | 2880.8 | 660433 |
| 918 | 842724 | 773620632 | 30.2985 | 9.7188 | 2.96284 | 1.08932 | 2884.0 | 661874 |
| 919 | 844561 | 776151559 | 30.3150 | 9.7224 | 2.96332 | 1.08814 | 2887.1 | 663317 |
| 920 | 846400 | 778688000 | 30.3315 | 9.7259 | 2.96379 | 1.08696 | 2890.3 | 664761 |
| 921 | 848241 | 781229961 | 30.3480 | 9.7294 | 2.96426 | 1.08578 | 2893.4 | 666207 |
| 922 | 850084 | 783777448 | 30.3645 | 9.7329 | 2.96473 | 1.08460 | 2896.5 | 667654 |
| 923 | 851929 | 786330467 | 30.3809 | 9.7364 | 2.96520 | 1.08342 | 2899.7 | 669103 |
| 924 | 853776 | 788889024 | 30.3974 | 9.7400 | 2.96567 | 1.08225 | 2902.8 | 670554 |
| 925 | 855625 | 791453125 | 30.4138 | 9.7435 | 2.96614 | 1.08108 | 2906.0 | 672006 |
| 926 | 857476 | 794022776 | 30.4302 | 9.7470 | 2.96661 | 1.07991 | 2909.1 | 673460 |
| 927 | 859329 | 796597983 | 30.4467 | 9.7505 | 2.96708 | 1.07875 | 2912.3 | 674915 |
| 928 | 861184 | 799178752 | 30.4631 | 9.7540 | 2.96755 | 1.07759 | 2915.4 | 676372 |
| 929 | 863041 | 801765089 | 30.4795 | 9.7575 | 2.96802 | 1.07643 | 2918.5 | 677831 |
| 930 | 864900 | 804357000 | 30.4959 | 9.7610 | 2.96848 | 1.07527 | 2921.7 | 679291 |
| 931 | 866761 | 806954491 | 30.5123 | 9.7645 | 2.96895 | 1.07411 | 2924.8 | 680752 |
| 932 | 868624 | 809557568 | 30.5287 | 9.7680 | 2.96942 | 1.07296 | 2928.0 | 682216 |
| 933 | 870489 | 812166237 | 30.5450 | 9.7715 | 2.96988 | 1.07181 | 2931.1 | 683680 |
| 934 | 872356 | 814780504 | 30.5614 | 9.7750 | 2.97035 | 1.07066 | 2934.2 | 685147 |
| 935 | 874225 | 817400375 | 30.5778 | 9.7785 | 2.97081 | 1.06952 | 2937.4 | 686615 |
| 936 | 876096 | 820025856 | 30.5941 | 9.7819 | 2.97128 | 1.06838 | 2940.5 | 688084 |
| 937 | 877969 | 822656953 | 30.6105 | 9.7854 | 2.97174 | 1.06724 | 2943.7 | 689555 |
| 938 | 879844 | 825293672 | 30.6268 | 9.7889 | 2.97220 | 1.06610 | 2946.8 | 691028 |
| 939 | 881721 | 827936019 | 30.6431 | 9.7924 | 2.97267 | 1.06496 | 2950.0 | 692502 |
| 940 | 883600 | 830584000 | 30.6594 | 9.7959 | 2.97313 | 1.06383 | 2953.1 | 693978 |
| 941 | 885481 | 833237621 | 30.6757 | 9.7993 | 2.97359 | 1.06270 | 2956.2 | 695455 |
| 942 | 887364 | 835896888 | 30.6920 | 9.8028 | 2.97405 | 1.06157 | 2959.4 | 696934 |
| 943 | 889249 | 838561807 | 30.7083 | 9.8063 | 2.97451 | 1.06045 | 2962.5 | 698415 |
| 944 | 891136 | 841232384 | 30.7246 | 9.8097 | 2.97497 | 1.05932 | 2965.7 | 699897 |
| 945 | 893025 | 843908625 | 30.7409 | 9.8132 | 2.97543 | 1.05820 | 2968.8 | 701380 |
| 946 | 894916 | 846590536 | 30.7571 | 9.8167 | 2.97589 | 1.05708 | 2971.9 | 702865 |
| 947 | 896809 | 849278123 | 30.7734 | 9.8201 | 2.97635 | 1.05597 | 2975.1 | 704352 |
| 948 | 898704 | 851971392 | 30.7896 | 9.8236 | 2.97681 | 1.05485 | 2978.2 | 705840 |
| 949 | 900601 | 854670349 | 30.8058 | 9.8270 | 2.97727 | 1.05374 | 2981.4 | 707330 |

# Functions of Numbers, 950 to 999

| No. | Square | Cube | Square Root | Cube Root | Logarithm | 1000 x Reciprocal | No. = Diameter | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Circum. | Area |
| 950 | 902500 | 857375000 | 30.8221 | 9.8305 | 2.97772 | 1.05263 | 2984.5 | 708822 |
| 951 | 904401 | 860085351 | 30.8383 | 9.8339 | 2.97818 | 1.05152 | 2987.7 | 710315 |
| 952 | 906304 | 862801408 | 30.8545 | 9.8374 | 2.97864 | 1.05042 | 2990.8 | 711809 |
| 953 | 908209 | 865523177 | 30.8707 | 9.8408 | 2.97909 | 1.04932 | 2993.9 | 713306 |
| 954 | 910116 | 868250664 | 30.8869 | 9.8443 | 2.97955 | 1.04822 | 2997.1 | 714803 |
| 955 | 912025 | 870983875 | 30.9031 | 9.8477 | 2.98000 | 1.04712 | 3000.2 | 716303 |
| 956 | 913936 | 873722816 | 30.9192 | 9.8511 | 2.98046 | 1.04603 | 3003.4 | 717804 |
| 957 | 915849 | 876467493 | 30.9354 | 9.8546 | 2.98091 | 1.04493 | 3006.5 | 719306 |
| 958 | 917764 | 879217912 | 30.9516 | 9.8580 | 2.98137 | 1.04384 | 3009.6 | 720810 |
| 959 | 919681 | 881974079 | 30.9677 | 9.8614 | 2.98182 | 1.04275 | 3012.8 | 722316 |
| 960 | 921600 | 884736000 | 30.9839 | 9.8648 | 2.98227 | 1.04167 | 3015.9 | 723823 |
| 961 | 923521 | 887503681 | 31.0000 | 9.8683 | 2.98272 | 1.04058 | 3019.1 | 725332 |
| 962 | 925444 | 890277128 | 31.0161 | 9.8717 | 2.98318 | 1.03950 | 3022.2 | 726842 |
| 963 | 927369 | 893056347 | 31.0322 | 9.8751 | 2.98363 | 1.03842 | 3025.4 | 728354 |
| 964 | 929296 | 895841344 | 31.0483 | 9.8785 | 2.98408 | 1.03734 | 3028.5 | 729867 |
| 965 | 931225 | 898632125 | 31.0644 | 9.8819 | 2.98453 | 1.03627 | 3031.6 | 731382 |
| 966 | 933156 | 901428696 | 31.0805 | 9.8854 | 2.98498 | 1.03520 | 3034.8 | 732899 |
| 967 | 935089 | 904231063 | 31.0966 | 9.8888 | 2.98543 | 1.03413 | 3037.9 | 734417 |
| 968 | 937024 | 907039232 | 31.1127 | 9.8922 | 2.98588 | 1.03306 | 3041.1 | 735937 |
| 969 | 938961 | 909853209 | 31.1288 | 9.8956 | 2.98632 | 1.03199 | 3044.2 | 737458 |
| 970 | 940900 | 912673000 | 31.1448 | 9.8990 | 2.98677 | 1.03093 | 3047.3 | 738981 |
| 971 | 942841 | 915498611 | 31.1609 | 9.9024 | 2.98722 | 1.02987 | 3050.5 | 740506 |
| 972 | 944784 | 918330048 | 31.1769 | 9.9058 | 2.98767 | 1.02881 | 3053.6 | 742032 |
| 973 | 946729 | 921167317 | 31.1929 | 9.9092 | 2.98811 | 1.02775 | 3056.8 | 743559 |
| 974 | 948676 | 924010424 | 31.2090 | 9.9126 | 2.98856 | 1.02669 | 3059.9 | 745088 |
| 975 | 950625 | 926859375 | 31.2250 | 9.9160 | 2.98900 | 1.02564 | 3063.1 | 746619 |
| 976 | 952576 | 929714176 | 31.2410 | 9.9194 | 2.98945 | 1.02459 | 3066.2 | 748151 |
| 977 | 954529 | 932574833 | 31.2570 | 9.9227 | 2.98989 | 1.02354 | 3069.3 | 749685 |
| 978 | 956484 | 935441352 | 31.2730 | 9.9261 | 2.99034 | 1.02249 | 3072.5 | 751221 |
| 979 | 958441 | 938313739 | 31.2890 | 9.9295 | 2.99078 | 1.02145 | 3075.6 | 752758 |
| 980 | 960400 | 941192000 | 31.3050 | 9.9329 | 2.99123 | 1.02041 | 3078.8 | 754296 |
| 981 | 962361 | 944076141 | 31.3209 | 9.9363 | 2.99167 | 1.01937 | 3081.9 | 755837 |
| 982 | 964324 | 946966168 | 31.3369 | 9.9396 | 2.99211 | 1.01833 | 3085.0 | 757378 |
| 983 | 966289 | 949862087 | 31.3528 | 9.9430 | 2.99255 | 1.01729 | 3088.2 | 758922 |
| 984 | 968256 | 952763904 | 31.3688 | 9.9464 | 2.99300 | 1.01626 | 3091.3 | 760466 |
| 985 | 970225 | 955671625 | 31.3847 | 9.9497 | 2.99344 | 1.01523 | 3094.5 | 762013 |
| 986 | 972196 | 958585256 | 31.4006 | 9.9531 | 2.99388 | 1.01420 | 3097.6 | 763561 |
| 987 | 974169 | 961504803 | 31.4166 | 9.9565 | 2.99432 | 1.01317 | 3100.8 | 765111 |
| 988 | 976144 | 964430272 | 31.4325 | 9.9598 | 2.99476 | 1.01215 | 3103.9 | 766662 |
| 989 | 978121 | 967361669 | 31.4484 | 9.9632 | 2.99520 | 1.01112 | 3107.0 | 768214 |
| 990 | 980100 | 970299000 | 31.4643 | 9.9666 | 2.99564 | 1.01010 | 3110.2 | 769769 |
| 991 | 982081 | 973242271 | 31.4802 | 9.9699 | 2.99607 | 1.00908 | 3113.3 | 771325 |
| 992 | 984064 | 976191488 | 31.4960 | 9.9733 | 2.99651 | 1.00806 | 3116.5 | 772882 |
| 993 | 986049 | 979146657 | 31.5119 | 9.9766 | 2.99695 | 1.00705 | 3119.6 | 774441 |
| 994 | 988036 | 982107784 | 31.5278 | 9.9800 | 2.99739 | 1.00604 | 3122.7 | 776002 |
| 995 | 990025 | 985074875 | 31.5436 | 9.9833 | 2.99782 | 1.00503 | 3125.9 | 777564 |
| 996 | 992016 | 988047936 | 31.5595 | 9.9866 | 2.99826 | 1.00402 | 3129.0 | 779128 |
| 997 | 994009 | 991026973 | 31.5753 | 9.9900 | 2.99870 | 1.00301 | 3132.2 | 780693 |
| 998 | 996004 | 994011992 | 31.5911 | 9.9933 | 2.99913 | 1.00200 | 3135.3 | 782260 |
| 999 | 998001 | 997002999 | 31.6070 | 9.9967 | 2.99957 | 1.00100 | 3138.5 | 783828 |

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

## Standard Specifications for
# Structural Steel for Buildings
## Serial Designation: A9—14

Adopted, 1901; Revised, 1909, 1913, 1914

### I. MANUFACTURE

1. Process—(*a*) Structural steel, except as noted in Paragraph (*b*), may be made by the Bessemer or the open-hearth process.

(*b*) Rivet steel, and steel for plates or angles over ¾ inch in thickness which are to be punched, shall be made by the open-hearth process.

### II. CHEMICAL PROPERTIES AND TESTS

2. Chemical Composition—The steel shall conform to the following requirements as to chemical composition:

| | | Structural Steel | Rivet Steel |
|---|---|---|---|
| Phosphorus | Bessemer | not over 0.10 per cent. | ...... |
| | Open-hearth | not over 0.06 per cent. | not over 0.06 per cent. |
| Sulphur | | | not over 0.045 per cent. |

3. Ladle Analyses—An analysis to determine the percentages of carbon, manganese, phosphorus and sulphur shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 2.

4. Check Analyses—Analyses may be made by the purchaser from finished material representing each melt, in which case an excess of 25 per cent above the requirements specified in Section 2 ...ll be allowed.

## Specifications for Steel for Buildings
Continued

### III. PHYSICAL PROPERTIES AND TESTS

5. TENSION TESTS—(*a*) The material shall conform to the following requirements as to tensile properties:

| Properties Considered | Structural Steel | Rivet Steel |
|---|---|---|
| Tensile strength, lbs. per sq. in..... | 55,000-65,000 | 46,000-56,000 |
| Yield point, min., lbs. per sq. in.... | 0.5 tens. str. | 0.5 tens. str. |
| Elongation in 8 in., min., per cent... | $\frac{1,400,000}{\text{Tens. str.}}$ [a] | $\frac{1,400,000}{\text{Tens. str.}}$ |
| Elongation in 2 in., min., per cent... | 22 | ...... |

[a] See Section 6

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

6. MODIFICATIONS IN ELONGATION—(*a*) For structural steel over ¾ inch in thickness, a deduction of 1 from the percentage of elongation in 8 inches specified in Section 5(*a*) shall be made for each increase of ⅛ inch in thickness above ¾ inch, to a minimum of 18 per cent.

(*b*) For structural steel under $\frac{5}{16}$ inch in thickness, a deduction of 2.5 from the percentage of elongation in 8 inches specified in Section 5 (*a*) shall be made for each decrease of $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch.

7. BEND TESTS—(*a*) The test specimen for plates, shapes and bars, except as specified in Paragraphs (*b*) and (*c*), shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: For material ¾ inch or under in thickness, flat on itself; for material over ¾ inch to and including 1¼ inches in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) The test specimen for pins, rollers and other bars, when prepared as specified in Section 8 (*e*), shall bend cold through 180 degrees around a 1-inch pin without cracking on the outside of the bent portion.

## Specifications for Steel for Buildings

**Continued**

(*c*) The test specimen for rivet steel shall bend cold throu 180 degrees flat on itself without cracking on the outside of t bent portion.

8. Test Specimens—(*a*) Tension and bend test specime shall be taken from rolled steel in the condition in which it com from the rolls, except as specified in Paragraph (*b*).

(*b*) Tension and bend test specimens for pins and roll shall be taken from the finished bars, after annealing when anne ing is specified.

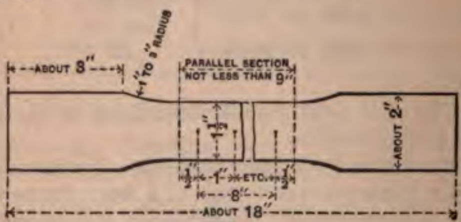



FIG. 1

(*c*) Tension and bend test specimens for plates, shap and bars, except as specified in Paragraphs (*d*), (*e*) and (*f*), sh be of the full thickness of material as rolled; and may be machin to the form and dimensions shown in Fig. 1, or with both edg parallel.

(*d*) Tension and bend test specimens for plates over 1 inches in thickness or diameter may be machined to a thickness diameter of at least ¾ inch for a length of at least 9 inches.

(*e*) Tension test specimens for pins, rollers and bars ov 1½ inches in thickness or diameter may be of the form and dime sions shown in Fig. 2. Bend test specimens may be 1 by ½ in in section. The axis of the specimens shall be located at a point midway between the center and surface and shall be paral to the axis of the bar.

(*f*) Tension and bend test specimens for rivet steel sh be of the full-size section of bars as rolled.

9. Number of Tests—(*a*) One tension and one bend te ll be made from each melt; except that if material from one m

## Specifications for Steel for Buildings

**Continued**

differs ⅜ inch or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5 (*a*) and any part of the fracture is more than ¾ inch from the center of the gauge length of a 2-inch specimen or is outside the middle third of the gauge

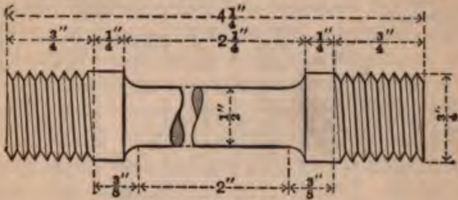



FIG. 2

length of an 8-inch specimen, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

### IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAUGE

10. PERMISSIBLE VARIATIONS—The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent. from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(*a*) *When Ordered to Weight*—For plates 12½ pounds per square foot or over:

Under 100 inches in width, 2.5 per cent. above or below the specified weight;

100 inches in width or over, 5 per cent. above or below the specified weight.

For plates under 12½ pounds per square foot:

Under 75 inches in width, 2.5 per cent. above or below the specified weight;

75 to 100 inches, exclusive, in width, 5 per cent. above or 3 per cent. below the specified weight;

100 inches in width or over, 10 per cent. above or 3 per cent. below the specified weight.

## Specifications for Steel for Buildings

**Continued**

(*b*) *When Ordered to Gauge*—The thickness of each plate shall not vary more than 0.01 inch under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

| Thickness Ordered, Inches | Nominal Weight, Pounds per Square Foot | Allowable Excess (Expressed as Percentage of Nominal Weight) For Width of Plate as follows: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Under 50 in. | 50 to 70 in., excl. | 70 in. or over. | Under 75 in. | 75 to 100 in., excl. | 100 to 115 in., excl. | 115 in. or over. |
| 1/8 to 5/32 | 5.10 to 6.37 | 10 | 15 | 20 | ...... | ...... | ...... | ...... |
| 5/32 to 3/16 | 6.37 to 7.65 | 8.5 | 12.5 | 17 | ...... | ...... | ...... | ...... |
| 3/16 to 1/4 | 7.65 to 10.20 | 7 | 10 | 15 | ...... | ...... | ...... | ...... |
| 1/4 | 10.20 | .... | ...... | ...... | 10 | 14 | 18 | ...... |
| 5/16 | 12.75 | .... | ...... | ...... | 8 | 12 | 16 | ...... |
| 3/8 | 15.30 | .... | ...... | ...... | 7 | 10 | 13 | 17 |
| 7/16 | 17.85 | .... | ...... | ...... | 6 | 8 | 10 | 13 |
| 1/2 | 20.40 | .... | ...... | ...... | 5 | 7 | 9 | 12 |
| 9/16 | 22.95 | .... | ...... | ...... | 4.5 | 6.5 | 8.5 | 11 |
| 5/8 | 25.50 | .... | ...... | ...... | 4 | 6 | 8 | 10 |
| Over 5/8 | ............ | .... | ...... | ...... | 3.5 | 5 | 6.5 | 9 |

### V. FINISH

11. The finished material shall be free from injurious defects and shall have a workmanlike finish.

### VI. MARKING

12. The name or brand of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that rivet and lattice bars and other small sections shall, when loaded for shipment, be properly separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

## Specifications for Steel for Buildings
**Continued**

### VII. INSPECTION AND REJECTION

13. INSPECTION—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

14. REJECTION—(*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 4 shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

15. REHEARING—Samples tested in accordance with Section 4, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

Standard Specifications for

# Structural Steel for Bridges

Serial Designation: A7-15

Adopted, 1901; Revised, 1905, 1909, 1913, 1914, 1915

1. STEEL CASTINGS—The Standard Specifications for Steel Castings adopted by the American Society for Testing Materials shall govern the purchase of steel castings for bridges. Unless otherwise specified, Class B castings, medium grade, shall be used.

## I. MANUFACTURE

2. PROCESS—The steel shall be made by the open-hearth process.

## II. CHEMICAL PROPERTIES AND TESTS

3. CHEMICAL COMPOSITION—The steel shall conform to the following requirements as to chemical composition:

| | | STRUCTURAL STEEL | RIVET STEEL |
|---|---|---|---|
| Phosphorus | Acid | not over 0.06 | not over 0.04 per cent. |
| | Basic | not over 0.04 | not over 0.04 per cent. |
| Sulphur | | not over 0.05 | not over 0.045 per cent. |

4. LADLE ANALYSES—An analysis to determine the percentages of carbon, manganese, phosphorus and sulphur shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 3.

5. CHECK ANALYSES—Analyses may be made by the purchaser from finished material representing each melt, in which case an excess of 25 per cent. above the requirements specified in Section 3 l be allowed.

## Specifications for Steel for Bridges

Continued

### III. PHYSICAL PROPERTIES AND TESTS

6. TENSION TESTS—(*a*) The material shall conform to the following requirements as to tensile properties:

| Properties Considered | Structural Steel | Rivet Steel |
|---|---|---|
| Tensile strength, lbs. per sq. in..... | 55,000-65,000[a] | 46,000-56,000 |
| Yield point, min., lbs. per sq. in.... | 0.5 tens. str. | 0.5 tens. str. |
| Elongation in 8 in., min., per cent... | $\frac{1,500,000}{\text{Tens. str.}}$[b] | $\frac{1,500,000}{\text{Tens. str.}}$ |
| Elongation in 2 in., min., per cent... | 22 | ...... |

*a* See Paragraph (*b*).
*b* See Section 7.

(*b*) In order to meet the required minimum tensile strength of full-size annealed eye bars, the purchaser may determine the tensile strength to be obtained in specimen tests; the range shall not exceed 14,000 pounds per square inch, and the maximum shall not exceed 74,000 pounds per square inch. The material shall conform to the requirements as to physical properties other than that of tensile strength, specified in Sections 6, 7 and 8 (*b*).

(*c*) The yield point shall be determined by the drop of the beam of the testing machine.

7. MODIFICATIONS IN ELONGATION—(*a*) For structural steel over ¾ inch in thickness, a deduction of 1 from the percentage of elongation in 8 inches specified in Section 6 (*a*) shall be made for each increase of ⅛ inch in thickness above ¾ inch, to a minimum of 18 per cent.

(*b*) For structural steel under $\frac{5}{16}$ inch in thickness, a deduction of 2.5 from the percentage of elongation in 8 inches specified in Section 6 (*a*) shall be made for each decrease of $\frac{1}{16}$ inch in thickness below $\frac{5}{16}$ inch.

8. BEND TESTS—(*a*) The test specimen for plates, shapes and bars, except as specified in paragraphs (*b*), (*c*) and (*d*), shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: For material ¾ inch or under in thickness, flat on itself; for material over ¾ inch to and

## Specifications for Steel for Bridges

**Continued**

including 1¼ inches in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) The test specimen for eye-bar flats shall bend cold through 180 degrees without cracking on the outside of the bent portion as follows: For material ¾ inch or under in thickness, around a pin the diameter of which is equal to the thickness of the

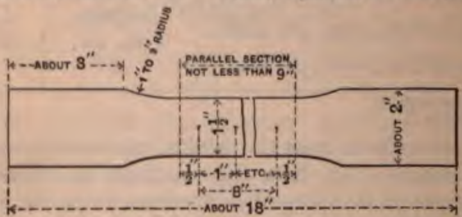


FIG. 1

specimen; for material over ¾ inch to and including 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to three times the thickness of the specimen.

(*c*) The test specimen for pins, rollers and other bars, when prepared as specified in Section 9 (*e*), shall bend cold through 180 degrees around a 1-inch pin without cracking on the outside of the bent portion.

(*d*) The test specimen for rivet steel shall bend cold through 180 degrees flat on itself without cracking on the outside of the bent portion.

9. TEST SPECIMENS—(*a*) Tension and bend test specimens shall be taken from rolled steel in the condition in which it comes from the rolls, except as specified in Paragraph (*b*).

(*b*) Tension and bend test specimens for pins and rollers shall be taken from the finished bars, after annealing when annealing is specified.

(*c*) Tension and bend test specimens for plates, shapes and bars except as specified in Paragraphs (*d*), (*e*) and (*f*), shall be of

## Specifications for Steel for Bridges

**Continued**

the full thickness of material as rolled. They may be machined to the form and dimensions shown in Fig. 1, or with both edges parallel; except that bend test specimens for eye-bar flats may have three rolled sides.

(*d*) Tension and bend test specimens for plates, and tension test specimens for eye-bar flats, over 1½ inches in thickness may be machined to a thickness or diameter of at least ¾ inch for a length of at least 9 inches.

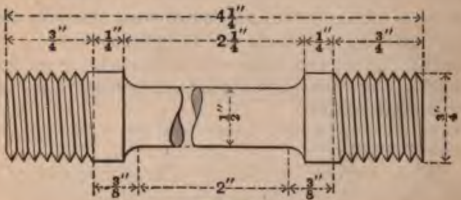



FIG. 2

(*e*) Tension test specimens for pins, rollers and bars (except eye-bar flats) over 1½ inches in thickness or diameter may be of the form and dimensions shown in Fig. 2. Bend test specimens may be 1 by ½ inch in section. The axis of the specimen shall be located at any point midway between the center and surface and shall be parallel to the axis of the bar.

(*f*) Tension and bend test specimens for rivet steel shall be of the full-size section of bars as rolled.

10. NUMBER OF TESTS—(*a*) One tension and one bend test shall be made from each melt; except that if material from one melt differs ⅜ inch or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6 (*a*) and any part of the fracture is more than ¾ inch from the center of the gauge length of a 2-inch specimen or is outside the middle third of the gauge length of an 8-inch specimen, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

# Specifications for Steel for Bridges

**Continued**

## IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAUGE

11. PERMISSIBLE VARIATIONS—The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent. from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(a) *When Ordered to Weight*—For plates 12½ pounds per square foot or over:

Under 100 inches in width, 2.5 per cent. above or below the specified weight;

100 inches in width or over, 5 per cent. above or below the specified weight.

For plates under 12½ pounds per square foot:

Under 75 inches in width, 2.5 per cent. above or below the specified weight;

75 to 100 inches, exclusive, in width, 5 per cent. above or 3 per cent. below the specified weight;

100 inches in width or over, 10 per cent. above or 3 per cent. below the specified weight.

(b) *When Ordered to Gauge*—The thickness of each plate shall not vary more than 0.01 inch under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

| Thickness Ordered, Inches | Nominal Weight, Pounds per Square Foot | Allowable Excess (Expressed as Percentage of Nominal Weight) For Width of Plate as follows: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Under 50 in. | 50 to 70 in., excl. | 70 in. or over. | Under 75 in. | 75 to 100 in., excl. | 100 to 115 in., excl. | 115 in. or over. |
| 1/8 to 5/32 | 5.10 to 6.37 | 10 | 15 | 20 | ...... | ...... | ...... | ...... |
| 5/32 to 3/16 | 6.37 to 7.65 | 8.5 | 12.5 | 17 | ...... | ...... | ...... | ...... |
| 3/16 to 1/4 | 7.65 to 10.20 | 7 | 10 | 15 | ...... | ...... | ...... | ...... |
| 1/4 | 10.20 | .... | ...... | ...... | 10 | 14 | 18 | ...... |
| 5/16 | 12.75 | .... | ...... | ...... | 8 | 12 | 16 | ...... |
| 3/8 | 15.30 | .... | ...... | ...... | 7 | 10 | 13 | 17 |
| 7/16 | 17.85 | .... | ...... | ...... | 6 | 8 | 10 | 13 |
| 1/2 | 20.40 | .... | ...... | ...... | 5 | 7 | 9 | 12 |
| 9/16 | 22.95 | .... | ...... | ...... | 4.5 | 6.5 | 8.5 | 11 |
| 5/8 | 25.50 | .... | ...... | ...... | 4 | 6 | 8 | 10 |
| Over 5/8 | ............ | .... | ...... | ...... | 3.5 | 5 | 6.5 | 9 |

## Specifications for Steel for Bridges

**Continued**

### V. FINISH

12. FINISH—The finished material shall be free from injurious defects and shall have a workmanlike finish.

### VI. MARKING

13. MARKING—The name or brand of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that rivet and lattice bars and other small sections shall, when loaded for shipment, be properly separated and marked for identification. The identification marks shall be legibly stamped on the end of each pin and roller. The melt number shall be legibly marked, by stamping if practicable, on each test specimen.

### VII. INSPECTION AND REJECTION

14. INSPECTION—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

15. REJECTION—(*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

16. REHEARING—Samples tested in accordance with Section 5, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

## Standard Specifications for

# Steel Castings

### Serial Designation: A27-14

Adopted, 1901; Revised, 1905, 1912, 1913, 1914

1. CLASSES—These specifications cover two classes of castings, namely:

*Class A*, ordinary castings for which no physical requirements are specified;

*Class B*, castings for which physical requirements are specified. These are of three grades: hard, medium and soft.

2. PATTERNS—(*a*) Patterns shall be made so that sufficient finish is allowed to provide for all variations in shrinkage.

(*b*) Patterns shall be painted three colors to represent metal, cores and finished surfaces. It is recommended that core prints shall be painted black and finished surfaces red.

3. BASIS OF PURCHASE—The purchaser shall indicate his intention to substitute the test to destruction specified in Section 11 for the tension and bend tests, and shall designate the patterns from which castings for this test shall be made.

## I. MANUFACTURE

4. PROCESS—The steel may be made by the open-hearth, crucible, or any other process approved by the purchaser.

5. HEAT TREATMENT—(*a*) Class A castings need not be annealed unless so specified.

(*b*) Class B castings shall be allowed to become cold. They shall then be uniformly reheated to the proper temperature to ﬁne the grain (a group thus reheated being known as an "annealing

## Specifications for Steel Castings

**Continued**

charge"), and allowed to cool uniformly and slowly. If, in the opinion of the purchaser or his representative, a casting is not properly annealed, he may at his option require the casting to be re-annealed.

### II. CHEMICAL PROPERTIES AND TESTS

6. CHEMICAL COMPOSITION—The castings shall conform to the following requirements as to chemical composition:

| | CLASS A | CLASS B |
|---|---|---|
| Carbon | not over 0.30 per cent. | ...... |
| Phosphorus | not over 0.06 per cent. | not over 0.05 per cent. |
| Sulphur | | not over 0.05 per cent. |

7. LADLE ANALYSES—An analysis to determine the percentages of carbon, manganese, phosphorus and sulphur shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 6. Drillings for analysis shall be taken not less than ¼ inch beneath the surface of the test ingot.

8. CHECK ANALYSES—(*a*) Analyses of Class A castings may be made by the purchaser, in which case an excess of 20 per cent. above the requirement as to phosphorus specified in Section 6 shall be allowed. Drillings for analysis shall be taken not less than ¼ inch beneath the surface.

(*b*) Analyses of Class B castings may be made by the purchaser from a broken tension or bend test specimen, in which case an excess of 20 per cent. above the requirements as to phosphorus and sulphur specified in Section 6 shall be allowed. Drillings for analysis shall be taken not less than ¼ inch beneath the surface.

### III. PHYSICAL PROPERTIES AND TESTS

(FOR CLASS B CASTINGS ONLY)

9. TENSION TESTS—(*a*) The castings shall conform to the following minimum requirements as to tensile properties:

## Specifications for Steel Castings

**Continued**

| | Hard | Medium | Soft |
|---|---|---|---|
| Tensile strength, lbs. per sq. in. | 80,000 | 70,000 | 60,000 |
| Yield point, lbs. per sq. in. | 36,000 | 31,500 | 27,000 |
| Elongation in 2 in., per cent | 15 | 18 | 22 |
| Reduction of area, per cent | 20 | 25 | 30 |

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

10. Bend Tests—(*a*) The test specimen for soft castings shall bend cold through 120 degrees, and for medium castings through 90 degrees, around a 1-inch pin, without cracking on the outside of the bent portion.

(*b*) Hard castings shall not be subject to bend test requirements.

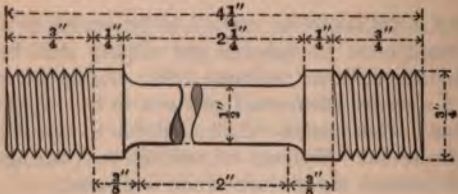


FIG. 2

11. Alternative Tests to Destruction—In the case of small or unimportant castings, a test to destruction on three castings from a lot may be substituted for the tension and bend tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. A lot shall consist of all castings from one melt, in the same annealing charge.

12. Test Specimens—(*a*) Sufficient test bars, from which the test specimens required in Section 13 (*a*) may be selected, shall be attached to castings weighing 500 pounds or over, when the design of the castings will permit. If the castings weigh less than 500 pounds, or are of such a design that test bars cannot be attached, two test bars shall be cast to represent each melt; or the quality of the castings shall be determined by tests to destruction as specified in Section 11. All test bars shall be annealed with the castings [illegible] represent.

## Specifications for Steel Castings

**Continued**

(*b*) The manufacturer and purchaser shall agree whether test bars can be attached to castings, on the location of the bars on the castings, on the castings to which bars are to be attached, and on the method of casting unattached bars.

(*c*) Tension test specimens shall be of the form and dimensions shown in Fig. 1. Bend test specimens shall be machined to 1 by ½ inch in section with corners rounded to a radius not over $\frac{1}{16}$ inch.

13. NUMBER OF TESTS—(*a*) One tension and one bend test shall be made from each annealing charge. If more than one melt is represented in an annealing charge, one tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 9 (*a*) and any part of the fracture is more than ¾ inch from the center of the gauge length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

### IV. WORKMANSHIP AND FINISH

14. WORKMANSHIP—The castings shall substantially conform to the sizes and shapes of the patterns, and shall be made in a workmanlike manner.

15. FINISH—(*a*) The castings shall be free from injurious defects.

(*b*) Minor defects which do not impair the strength of the castings may, with the approval of the purchaser or his representative, be welded by an approved process. The defects shall first be cleaned out to solid metal; and after welding, the castings shall be annealed, if specified by the purchaser or his representative.

(*c*) The castings offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to *such an extent* as to hide defects.

## Specifications for Steel Castings

**Continued**

### V. INSPECTION AND REJECTION

16. Inspection—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

17. Rejection—(*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 8 shall be reported within five working days from the receipt of samples.

(*b*) Castings which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

18. Rehearing—Samples tested in accordance with Section 8, which represent rejected castings, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

### VI. SPECIAL REQUIREMENTS FOR CASTINGS FOR SHIPS

19. Castings for Ships—In addition to the preceding requirements, castings for ships, when so specified, shall conform to the following requirements:

20. Heat Treatment—All castings shall be annealed.

21. Number of Tests—(*a*) One tension and one bend test shall be made from each of the following castings: stern frames, stern posts, twin screw spectacle frames, propeller shaft brackets, rudders, steering quadrants, tillers, stems, anchors, and other castings when specified.

(*b*) When a casting is made from more than one melt, four
n and four bend tests shall be made from each casting.

## Specifications for Steel Castings

Continued

22. Percussion Tests—(*a*) A percussion test shall be made on each of the following castings: stern frames, stern posts, twin screw spectacle frames, propellor shaft brackets, rudders, steering quadrants, tillers, stems, anchors, and other castings when specified.

(*b*) For this test, the casting shall be suspended by chains and hammered all over with a hammer of a weight approved by the purchaser or his representative. If cracks, flaws, defects, or weakness appear after such treatment, the casting will be rejected.

### VII. SPECIAL REQUIREMENTS FOR CASTINGS FOR RAILWAY ROLLING STOCK

23. Castings for Railway Rolling Stock—Castings for railway rolling stock, when so specified, shall conform to the requirements for Class B castings, Sections 1 to 18, inclusive, except that check analyses made in accordance with Section 8 (*b*) shall conform to the requirements as to phosphorus and sulphur specified in Section 6.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

## Standard Specifications for

# Boiler and Firebox Steel

### Serial Designation: A30-14

Adopted, 1901; Revised, 1909, 1912, 1913, 1914

1. GRADES—These specifications cover two grades of steel for boilers, namely: Flange and Firebox.

I. MANUFACTURE

2. PROCESS—The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS

3. CHEMICAL COMPOSITION—The steel shall conform to the following requirements as to chemical composition:

| | Flange | Firebox | |
|---|---|---|---|
| Carbon | | 0.12 — 0.25 | per cent. |
| Manganese | 0.30 — 0.60 | 0.30 — 0.50 | per cent. |
| Phosphorus, Acid | not over 0.05 | not over 0.04 | per cent. |
| Phosphorus, Basic | not over 0.04 | not over 0.035 | per cent. |
| Sulphur | not over 0.05 | not over 0.04 | per cent. |
| Copper | | not over 0.05 | per cent. |

4. LADLE ANALYSES—An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 3.

5. CHECK ANALYSES—Analyses may be made by the purchaser from a broken tension test specimen representing each plate as [illegible], which shall conform to the requirements specified in Section 3.

## Specifications for Boiler and Firebox Steel

Continued

### III. PHYSICAL PROPERTIES AND TESTS

6. TENSION TESTS—(*a*) The material shall conform to the following requirements as to tensile properties:

| | FLANGE | FIREBOX |
|---|---|---|
| Tensile strength, lbs. per sq. in. | 55,000 — 65,000 | 52,000 — 62,000 |
| Yield point, min., lbs. per sq. in. | 0.5 tens. str. | 0.5 tens. str. |
| Elongation in 8 in., min., per cent (See Section 7) | $\frac{1,500,000}{\text{Tens. str.}}$ | $\frac{1,500,000}{\text{Tens. str.}}$ |

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

7. MODIFICATIONS IN ELONGATION—(*a*) For material over ¾ inch in thickness, a deduction of 0.5 from the percentages of elongation specified in Section 6 (*a*) shall be made for each increase of ⅛ inch in thickness above ¾ inch.

(*b*) For material ¼ inch or under in thickness, the elongation shall be measured on a gauge length of 24 times the thickness of the specimen.

8. BEND TESTS—(*a*) *Cold-bend Tests*—The test specimen shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: For material 1 inch or under in thickness, flat on itself; and for material over 1 inch in thickness, around a pin the diameter of which is equal to the thickness of the specimen.

(*b*) *Quench-bend Tests*—The test specimen, when heated to a light cherry red as seen in the dark (not less than 1200 degrees Fahrenheit), and quenched at once in water the temperature of which is between 80 degrees and 90 degrees Fahrenheit, shall bend through 180 degrees without cracking on the outside of the bent portion, as follows: For material 1 inch or under in thickness, flat on itself; and for material over 1 inch in thickness, around a pin the diameter of which is equal to the thickness of the specimen.

9. HOMOGENEITY TESTS—For firebox steel, a sample taken from a broken tension test specimen shall not show any single seam or cavity more than ¼ inch long, in either of the three fractures obtained in the test for homogeneity, which shall be made as follows:

The specimen shall be either nicked with a chisel or grooved on a machine, transversely, about $\frac{1}{16}$ inch deep, in three p
2 inches apart. The first groove shall be made 2 inc

## Specifications for Boiler and Firebox Steel

**Continued**

square end; each succeeding groove shall be made on the opposite side from the preceding one. The specimen shall then be firmly held in a vise, with the first groove about ¼ inch above the jaws, and the projecting end broken off by light blows of a hammer, the bending being away from the groove. The specimen shall be broken at the other two grooves in the same manner. The object of this test is to open and render visible to the eye any seams due to failure to weld up or to interposed foreign matter, or any cavities

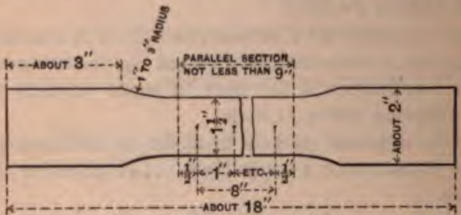



FIG. 1

due to gas bubbles in the ingot. One side of each fracture shall be examined and the lengths of the seams and cavities determined, a pocket lens being used if necessary.

10. TEST SPECIMENS—Tension and bend test specimens shall be taken from the finished rolled material. They shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

11. NUMBER OF TESTS—(*a*) One tension, one cold-bend, and one quench-bend test shall be made from each plate as rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6 (*a*) and any part of the fracture is outside the middle third of the gauge length, as indicated by scribe scratches marked on the specimen before testing, test shall be allowed.

# Specifications for Boiler and Firebox Steel

Continued

## IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAUGE

12. Permissible Variations—*When Ordered to Gauge*—The thickness of each plate shall not vary more than 0.01 inch under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 pound:

| Thickness Ordered, Inches | Nominal Weight, Pounds per Square Foot | Allowable Excess (Expressed as Percentage of Nominal Weight) For Width of Plate as follows: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Under 50 in. | 50 to 70 in., excl. | 70 in. or over. | Under 75 in. | 75 to 100 in., excl. | 100 to 115 in., excl. | 115 in. or over. |
| 1/8 to 5/32 | 5.10 to 6.37 | 10 | 15 | 20 | ...... | ...... | ...... | ...... |
| 5/32 to 3/16 | 6.37 to 7.65 | 8.5 | 12.5 | 17 | ...... | ...... | ...... | ...... |
| 3/16 to 1/4 | 7.65 to 10.20 | 7 | 10 | 15 | ...... | ...... | ...... | ...... |
| 1/4 | 10.20 | .... | ...... | ...... | 10 | 14 | 18 | ...... |
| 5/16 | 12.75 | .... | ...... | ...... | 8 | 12 | 16 | ...... |
| 3/8 | 15.30 | .... | ...... | ...... | 7 | 10 | 13 | 17 |
| 7/16 | 17.85 | .... | ...... | ...... | 6 | 8 | 10 | 13 |
| 1/2 | 20.40 | .... | ...... | ...... | 5 | 7 | 9 | 12 |
| 9/16 | 22.95 | .... | ...... | ...... | 4.5 | 6.5 | 8.5 | 11 |
| 5/8 | 25.50 | .... | ...... | ...... | 4 | 6 | 8 | 10 |
| Over 5/8 | ........... | .... | ...... | ...... | 3.5 | 5 | 6.5 | 9 |

## V. FINISH

13. Finish—The finished material shall be free from injurious defects and shall have a workmanlike finish.

## VI. MARKING

14. Marking—The name or brand of the manufacturer, melt or slab number, grade, and lowest tensile strength for its grade specified in Section 6 (*a*), shall be legibly stamped on eac[illegible] melt or slab number shall be legibly stamped on eac[illegible]

## Specifications for Boiler and Firebox Steel

**Continued**

### VII. INSPECTION AND REJECTION

15. INSPECTION—The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

16. REJECTION—(*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

17. REHEARING—Samples tested in accordance with Section 5, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

Standard Specifications for

# Structural Steel for Ships

## Serial Description: A12-14

Adopted, 1901; Revised, 1909, 1913, 1914

### I. MANUFACTURE

1. PROCESS—The steel shall be made by the open-hearth process.

### II. CHEMICAL PROPERTIES AND TESTS

2. CHEMICAL COMPOSITION—The steel shall conform to the following requirements as to chemical composition:

| | | |
|---|---|---|
| Phosphorus | Acid | not over 0.06 per cent. |
| | Basic | not over 0.04 per cent. |
| Sulphur | | not over 0.05 per cent. |

3. LADLE ANALYSES—An analysis to determine the percentages of carbon, manganese, phosphorus and sulphur shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section 2.

4. CHECK ANALYSES—Analyses may be made by the purchaser from finished material representing each melt, in which case an excess of 25 per cent. above the requirements specified in Section 2 shall be allowed.

### III. PHYSICAL PROPERTIES AND TESTS

5. TENSION TESTS—(*a*) The material shall conform to the following requirements as to tensile properties:

NOTE—The requirements for castings for ships have been especially provided for in the Standard Specifications for Steel Castings, adopted by th[illegible] Society for Testing Materials attached thereto.

## Specifications for Structural Steel for Ships

**Continued**

| | |
|---|---|
| Tensile strength, lbs. per sq. in. | 58,000 — 68,000 |
| Yield point, min., lbs. per sq. in. | 0.5 tens. str. |
| Elongation in 8 in., min., per cent (See Section 6.) | $\frac{1,500,000}{\text{Tens. str.}}$ |

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.


FIG. 1

6. Modifications in Elongation—(*a*) For material over ¾ inch in thickness, a deduction of 1 from the percentage of elongation specified in Section 5 (*a*) shall be made for each increase of ⅛ inch in thickness above ¾ inch, to a minimum of 18 per cent.

(*b*) For material ¼ inch or under in thickness, the elongation shall be measured on a gauge length of 24 times the thickness of the specimen.

7. Bend Tests—The test specimen shall bend cold through 180 degrees without cracking on the outside of the bent portion, as follows: For material ¾ inch or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; for material over ¾ inch to and including 1¼ inches in thickness, around a pin the diameter of which is equal to 1½ times the thickness of the specimen; and for material over 1¼ inches in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

8. Test Specimens—(*a*) Tension and bend test specimens shall be taken from the finished rolled material, and shall not be annealed or otherwise treated, except as specified in Paragraph (*b*).

(*b*) Tension and bend test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full ...on of the piece.

## Specifications for Structural Steel for Ships

**Continued**

(*c*) Tension and bend test specimens, except as specified in Paragraph (*d*), shall be of the full thickness of material as rolled; and may be machined to the form and dimensions shown in Fig. 1, or with both edges parallel.

(*d*) Tension and bend test specimens for plates and bars over 1½ inches in thickness or diameter may be machined to a thickness or diameter of at least ¾ inch for a length of at least 9 inches.

9. Number of Tests—(*a*) One tension and one bend test shall be made from each melt; except that if material from one melt differs ⅜ inch or more in thickness, one tension and one bend test shall be made from both the thickest and the thinnest material rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5 (*a*) and any part of the fracture is outside the middle third of the gauge length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

### IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAUGE

10. Permissible Variations—The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent. from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(*a*) *When Ordered to Weight*—For plates 12½ pounds per square foot or over:

Under 100 inches in width, 2.5 per cent. above or below the specified weight;
100 inches in width or over, 5 per cent. above or below the specified weight.

## Specifications for Structural Steel for Ships

**Continued**

For plates under 12½ pounds per square foot:

Under 75 inches in width, 2.5 per cent. above or below the specified weight;
75 to 100 inches, exclusive, in width, 5 per cent. above or 3 per cent. below the specified weight;
100 inches in width or over, 10 per cent. above or 3 per cent. below the specified weight.

(*b*) *When Ordered to Gauge*—The thickness of each plate shall not vary more than 0.01 inch under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 pound.

| Thickness Ordered, Inches | Nominal Weight, Pounds per Square Foot | Allowable Excess (Expressed as Percentage of Nominal Weight) For Width of Plate as follows: | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Under 50 in. | 50 to 70 in., excl. | 70 in. or over. | Under 75 in. | 75 to 100 in., excl. | 100 to 115 in., excl. | 115 in. or over. |
| 1/8 to 5/32 | 5.10 to 6.37 | 10 | 15 | 20 | ...... | ...... | ...... | ...... |
| 5/32 to 3/16 | 6.37 to 7.65 | 8.5 | 12.5 | 17 | ...... | ...... | ...... | ...... |
| 3/16 to 1/4 | 7.65 to 10.20 | 7 | 10 | 15 | ...... | ...... | ...... | ...... |
| 1/4 | 10.20 | .... | ...... | ...... | 10 | 14 | 18 | ...... |
| 5/16 | 12.75 | .... | ...... | ...... | 8 | 12 | 16 | ...... |
| 3/8 | 15.30 | .... | ...... | ...... | 7 | 10 | 13 | 17 |
| 7/16 | 17.85 | .... | ...... | ...... | 6 | 8 | 10 | 13 |
| 1/2 | 20.40 | .... | ...... | ...... | 5 | 7 | 9 | 12 |
| 9/16 | 22.95 | .... | ...... | ...... | 4.5 | 6.5 | 8.5 | 11 |
| 5/8 | 25.50 | .... | ...... | ...... | 4 | 6 | 8 | 10 |
| Over 5/8 | ............ | .... | ...... | ...... | 3.5 | 5 | 6.5 | 9 |

### V. FINISH

11. Finish—The finished material shall be free from injurious defects and shall have a workmanlike finish.

### VI. MARKING

12. Marking—The name or brand of the manufacturer and the melt number shall be legibly rolled or stamped on all finished material. The melt number shall be legibly stamped on each test specimen.

## Specifications for Structural Steel for Ships

Continued

### VII. INSPECTION AND REJECTION

13. INSPECTION—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

14. REJECTION—(*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 4 shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

15. REHEARING—Samples tested in accordance with Section 4, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

# Standard Specifications for
# Fabricated Steel Building Construction

**Adopted 1915**

## DESIGN

LOADING:

1st—All steel used for building construction shall be so designed as to safely resist all stresses coming from both dead and live loads. The dead load shall consist of the weight of the structure itself, together with all permanent fixtures and attachments, such as walls, roofs, floors, partitions, elevators, vaults and other permanent fixtures. The live load shall consist of the super-imposed loads on floors and roofs, also the exterior loads due to wind pressure, etc.

2nd—Where moving loads are to be provided for, such as cranes or car traffic of any kind, 25% shall be added to the stresses due to such moving loads to care for the impact and vibrations accompanying such loading.

3rd—Unless local conditions indicate other values as being probable, a wind pressure of twenty pounds per square foot on the vertical projection of all structures shall be provided for.

4th—All parts of the structure shall be of such sizes that the dead load or live load or the sum of the dead and live loads, plus impact allowances, if necessary, shall not exceed the following amounts in pounds per square inch:

| | |
|---|---|
| Tension, net section rolled steel | 16,000 |
| Direct compression rolled steel | 16,000 |
| Direct compression, steel castings | 16,000 |
| Direct compression, iron castings | 12,000 |
| Stresses in extreme fibers of rolled steel shapes, built sections, girders and steel castings when subject to flexure | 16,000 |
| Bending in extreme fibers of steel pins and steel slabs under columns | 24,000 |
| Shear on steel shop rivets and pins | 12,000 |
| Shear on turned bolts and field rivets | 10,000 |
| Shear on rough bolts | 8,000 |
| Shear in webs of steel plate girders and rolled beams | 10,000 |
| Bearing on steel shop rivets and pins | 24,000 |
| Bearing on turned bolts and field rivets | 20,000 |
| Bearing on rough bolts | 16,000 |
| Compression along longitudinal axis of rolled steel columns, per square inch, $16,000 \times 70 \frac{L}{R}$, with a maximum of 14,000 pounds. | |
| Compression along longitudinal axis of cast iron columns per square inch | $\dfrac{8,000}{1 \times \dfrac{L^2}{800d}}$ |

### Standard Specifications for

## Fabricated Steel Building Construction

**Continued**

In the foregoing formula L equals length of member in inches between points of support; R equals radius of gyration; D equals outside diameter.

The maximum length of any rolled steel section used in compression shall not exceed 150 times the least radius of gyration.

Where expansion rollers are used to provide for the expansion and contraction of a structure, due to changes in temperature, the maximum pressure per linear inch on such rollers shall not exceed 600 times the diameter of the rollers in inches.

For wind bracing, also for members subject to combined stresses due to wind and either dead or live loads or both, the permissible stresses per square inch, as mentioned above, may be increased 25%, provided that the section as determined under this paragraph be not less than that required for dead and live loads alone.

ECCENTRIC LOADING:

In determining sizes for compression members, full consideration shall be given the stresses due to eccentric loading. In determining areas for tension members, net sections only shall be considered, and, in deduction of rivet holes, the hole shall be assumed to be ⅛ inch greater in diameter than the nominal diameter of the rivets. Such members of the structure as are subject to both direct loading and transverse loading shall be so proportioned that the maximum fiber stress in the member shall not exceed the limits given above.

In members subject to both tension and compression, the greater stress shall be increased by 50% of the lesser, and the member shall then be designed for the stress requiring the larger section.

Connections for such members subject to such reversal of stress shall be proportioned for the sum of the two stresses.

Rolled beams and channels, also built up members used as girders or beams, shall be proportioned by the moment of inertia of their net section.

Webs of plate girders shall have a thickness of not less than $\frac{6}{10}$ of 1% of the unsupported distance of such webs between

### Standard Specifications for

## Fabricated Steel Building Construction

Continued

flange angles. Webs shall also be provided with stiffeners in pairs over bearings and at points of concentrated loading. Also when web thickness is less than $1\frac{6}{10}$% of the unsupported distance between flange angles, stiffeners shall be provided spaced not farther apart than the depth of the web plate. This spacing, however shall not exceed a maximum limit of six feet.

Where beams and girders are without lateral support for a distance exceeding ten times the width of a compression flange, then the stress per square inch in said compression flange shall not be permitted to exceed 19,000 minus 300 $\frac{L}{B}$, in which L equals unsupported length of the compression flange and B equals width of the compression flange, and providing further that no beam or girder shall be used in which the unsupported length of a compression flange exceeds forty times the width of said flange.

MINIMUM SECTIONS:

Except where used for ornamental purposes, or for fillers, or for smoke stacks, no steel is to be used less than ¼ inch thick, nor shall any lateral rods, sag rods or similar ties or braces be used having a less section than $\frac{2}{10}$ of one square inch at the smallest point.

GENERAL:

As a rule all adjustable members in any part of a structure are to be avoided and all built sections shall preferably be made symmetrical. With the exception of lattice bars and the intersections of diagonal bracing, ceiling hangers, etc., no connection shall have less than two rivets. In the construction of trusses, preference is to be given to riveted connections and only under exceptional circumstances shall pin connections be used. All abutting joints and compression members are to be accurately machine finished, so as to secure as uniform a bearing with the abutting member as can be obtained by such means. Further, such joints shall have splice plates with sufficient rivets to hold connecting members curately in place. Where compression members are not properly

Standard Specifications for

## Fabricated Steel Building Construction

Continued

machine finished, they shall be fully spliced. All tension members shall be fully spliced. Stiff bracing is also to be preferred for all wind bracing, sway bracing and lateral bracing. Adjustable rods for this purpose are not to be used without special sanction.

BEAM GIRDERS:

Where girders are composed of two or more rolled beams or rolled channels, they shall be connected at intervals of not more than five feet by bolts passing through their webs with cast iron or wrought steel separators or distance pieces to maintain them in their proper position. In lieu of such separators and separator bolts, it will be permissible to keep such beams or channels in position by using cover plates on either top flange or bottom flange, or both top and bottom flanges, or by the use of batten plates riveted to the flanges. Should such batten plates be used, they shall contain not less than two rivets in each plate for connection to each flange and shall be spaced at intervals not exceeding five feet. Where flange plates are used on girders, they shall be so limited in width as to not extend a greater distance beyond the outer line of rivets connecting them to the flanges or angles than 6 inches, or sixteen times the thickness of the thinnest flange plate used, unless special provision is made for holding the flanges in their nominal relation to the web of the girder.

STIFFENERS:

Web stiffeners on plate girders shall be used in pairs and shall fit closely against the flange angles. Stiffeners that are used over end bearings, or under points of concentrated load, or for forming connections between columns and girders, shall have a tight bearing against the flange angles. Where web plates of girders are not furnished in one piece, they shall be spliced by a plate on each side of the web with sufficient rivets to properly transmit the maximum shear coming at point of splicing.

RIVETS:

The minimum distance center to center of rivets shall preferably be not less than three inches for ⅞ inch diameter rivets,

### Standard Specifications for

## Fabricated Steel Building Construction

**Continued**

2½ inches for ¾ inch diameter rivets or two inches for ⅝ inch diameter rivets. In no case, however, shall it be less than three times the diameter of rivets used.

The maximum distance center to center of rivets in the line of stress, where built members composed of plates and shapes are used, shall be six inches or sixteen times the thinnest outside plate. For angles having two gauge lines with rivets staggered, the greatest pitch in each line shall be twice the above allowance.

Where two or more plates are in contact, they shall be held together with stitch rivets spaced not more than 12 inches apart, center to center in both directions.

The minimum distance from the center of any rivet hole to a sheared edge shall be 1½ inches for ⅞ inch diameter rivets, 1¼ inches for ¾ inch diameter rivets, 1⅛ inches for ⅝ inch diameter rivets, and the corresponding distance to a rolled edge shall be 1¼ inches, 1⅛ inches and 1 inch respectively.

The maximum distance from the center of any plate to the center of the nearest rivet shall not exceed eight times the thickness of the plate. For built members subject to compression, the pitch of the rivets at the ends of same shall not exceed four diameters of the rivets used for a length equal to 1½ times the width of said members.

LATTICING:

Where compression members are used that are composed of two or more pieces not connected by web plates or cover plates, they shall have their open sides connected by lattice bars, and be further provided with tie plates at each end, also at such intermediate points as it shall be necessary to interrupt the continuity of the lattice. Such end tie plates shall have a length not less than the distance between rows of rivets connecting them to the flanges of the member, and intermediate tie plates shall have a length of not less than one-half of this distance. The thickness of both end and intermediate tie plates shall not be less than two per cent. of this distance.

### Standard Specifications for

## Fabricated Steel Building Construction

**Continued**

All latticing used on compression members shall be of such sizes and shall have sufficient rivets to enable the latticing to resist a transverse shearing stress of not less than two per cent. of the total amount of the direct stress. Where a single system of latticing is used, the thickness of the lattice bars shall be not less than 2½%, or where a double system of latticing is used, not less than $1\frac{6}{10}$% of the distance between the end rivets connecting the lattice bars to the main members. Nor shall their width be less than 2½ inches for sections composed of 15-inch channels, or for built sections using 3½-inch or 4-inch angles; 2¼ inches for sections composed of 12, 10 and 9-inch channels or for built sections using 3-inch angles; 2 inches for 8 and 7-inch channels or for built sections using 2½-inch angles; or 1¾ inches for sections composed of 6 and 5-inch channels, or for built sections using 2-inch angles.

Lattice bars in no case shall be used with an inclination to the axis of the main member that is less than 45 degrees where double latticing is used, or 60 degrees where single latticing is used, and double latticing shall be used in all cases where the distance between rivet lines and the flanges of the main member is more than 15 inches. Care shall also be taken that the ratio of length to the radius of gyration of parts of the member that are connected by lattice bars is less than the ratio of total length of the member to the radius of gyration of the member as a whole.

PINS:

All pin holes shall be reinforced by pin plates wherever such reinforcement is necessary to keep the pressure of the pins on the surface of the pin hole within the limits of this specification. Where such pin plates are used, at least one plate shall be as wide as the projecting flanges will allow, and such pin plate shall contain sufficient rivets to properly distribute their proportion of pin pressure to the full cross section of the main member. All pins shall be long enough to insure a full bearing on all parts connecting with the turned body of the pin, and members connecting on the pin shall be properly held against lateral movement.

### Standard Specifications for

## Fabricated Steel Building Construction

**Continued**

All beams, channels and girders that derive their support from walls or piers shall be properly anchored to same, and shall further be provided with wall plates of such thickness and such area as to properly distribute the load coming from said beams, channels or girders on the wall or piers.

Where beams, channels, girders and other members act as skew-backs for floor arches, such beams, channels, girders and other members shall be duly designed to resist the lateral thrust coming from such arches, in addition to all other loads that they may be called upon to sustain.

Tie rods shall be placed as near to the spring of the arches as is practicable and shall be of such size as to enable them to properly resist the stresses coming upon them.

### WORKMANSHIP

SHEARING:

The workmanship shall be equal to the best practice in fully equipped structural shops. All shearing must be done accurately and all portions of the work present a neat and workmanlike finish.

PUNCHING:

The diameter of the punch shall not be more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivet, nor shall the diameter of the die be more than $\frac{1}{8}$ inch larger than the nominal diameter of the rivet. All punching must be done accurately. An occasional slight inaccuracy in the matching of holes may be corrected by reaming. Drifting for such purposes will not be allowed under any circumstances.

RIVETING:

Pressure tools shall be used wherever possible for the driving of rivets, and pneumatic hammers shall be used where the use of such pressure tools is not possible. Hand riveting will be allowed only under exceptional circumstances. All rivet heads shall be centered on the shank and shall be neat, full and of equal size and grip the assembled pieces closely.

### Standard Specifications for

## Fabricated Steel Building Construction

**Continued**

ASSEMBLING:

All riveted members shall be well pinned up and firmly bolted together before riveting is begun. All surfaces coming in contact shall be painted before assembling. All the abutting joints shall be accurately cut so as to make a snug fit, and when finished all riveted pieces shall be free from twists, bends and open joints. Where steel has been partially heated in the fabrication the entire piece shall be annealed when finished. All steel castings shall also be annealed before using. Welds in steel will not be allowed under any circumstances.

PAINTING:

Except where members are to be embedded in concrete all steel shall be thoroughly cleaned with wire brushes and be given one thorough coat of an approved paint, well worked into all joints and seams before leaving the fabricating shop. No castings of any kind, however, shall be painted until after inspection and acceptance by the inspector.

EYE BARS:

Where eye bars are used they shall be straight and true to size, free from twists, folds or seams in neck or head. Heads shall be made by upsetting or forging as welded heads will not be allowed. Pin holes shall be on the center line of the bar and in the center of the heads. The boring of pin holes shall be done with such accuracy that when bars of same length are placed together a pin $\frac{1}{32}$ inch smaller in diameter than the pin holes can be passed through the holes at both ends of the bars at the same time.

PINS:

Pins and rollers shall be accurately turned to gauge and are to be straight, smooth and free from flaws. Pin holes shall be bored true to gauge, smooth and straight and at right angles to the axis of the member through which they pass. Such boring to be done after the member is riveted up.

INSPECTION:

Full facilities shall be furnished by the manufacturer for inspecting and testing the quality of the material, the workmanship and the weights, including the use of a suitable testing machine. Inspector shall also have free access to all parts of the works where material embraced in this contract is being manufactured.

# INDEX

PAGE
Allowable Uniform Loads for Angles....160-162
Beams....147-154
Channels....155-159
Girders....167-175
Tees....163-164
Wooden Beams....276-280
Zees....165-166
American Society for Testing Materials, Specifications....342-369
Anchors and Tie Rods....226
Angles, Allowable Uniform Loads for....160-162
Area Deducted for Hole....247
Areas of.... 46
Diagrams, Sizes and Weights....26-35
Location of Connecting....127-128
Properties of....109-119
Radii of Gyration....207-209
Angle and Plate Columns, Safe Loads....184-193
Arches, Terra Cotta....225
Area Deducted for Hole in Plates, Bars and Angles....247
Areas and Circumferences....322-341
Areas, Method of Increasing Sectional.... 9
of Angles.... 46
Bars and Plates....55-56
Circular Sections....307-308
Plane Figures....309
Square and Round Bars....49-54
Bars, Area Deducted for Hole....247
Areas of....55-56
Circumferences of Round....49-54
Concrete....80-81
Diamond.... 81
Screw Ends for....264-265
Sizes, Weights and Areas of Square and Round....47-54
Weights of Flat....57-70
m and Channel Connections....126

# INDEX

PAGE

Beam Box Girders, Allowable Uniform Loads.....167-171
Beam Bridges, Details for I.....244
Beam Columns, Safe Loads for Single.....182-183
Beam Connections, Limiting Values of.....129
Beams, Allowable Uniform Loads.....147-154
Bearing Plates for.....132
Bending Moments and Deflection of.....141-146
Capacity of.....140
Cast Separators for.....130-131
Common Dimensions of..... 10
Diagrams Sizes and Weights of.....11-18
Loads on.....133-134
Properties of.....105-106
Structural Sections Used as.....135-140
Wooden.....271-280
Bearing and Shearing Values of Rivets.....252-253
Bearing Plates, Standard.....132
Bearing Values for Pin Plates.....259
Bending Moments and Deflection of Beams.....141-146
for Pins.....258
Boiler Steel, Standard Specifications for.....360-364
Bolt Heads, Standard.....260
Weight of.....261
Bolt Holes, Spacing and Dimensions.....248
Bolts, Allowable Unit Stress.....129
Anchor and Wedge.....226
Machine.....261
Box Girders, Allowable Uniform Loads.....167-173
Bridge Pins.....256
Bridge, Details for, I-Beam.....244
Standard Specifications of Steel for.....348-353
Building Construction, Specifications for Fabricated Steel for 371-377
Building Laws as to Floor and Roof Loads.....243
Materials, Weights, etc.....292
Standard Specifications of Steel for.....342-347
Castings, Standard Specifications for Steel.....354-359

# INDEX

PAGE
Cast Iron Columns, Safe Loads....204-205
Cast Separators for Beams....130-131
Chain....90-94
Channel and Beam Connections....126
Channel Columns, Safe Loads for....194-203
Channels, Allowable Uniform Loads for....155-159
 Bearing Plates for....132
 Common Dimensions of.... 10
 Diagrams, Sizes and Weights ....19-25
 Properties of....107-108
Circles, Properties of....306
Circular Plates, Sizes and Weights....75-79
Circular Sections, Areas of....307-308
Circumferences of Round Bars.....49-54
Circumferences and Areas....322-341
Clevis Nuts....267
Columns....176-205
 Bases....179
 Formula for Safe Loads....177
 Details of Splices for....180
 Lattice Bars and Tie Plates....181
 Safe Loads for....182-205
 Typical Built Sections....179
 Typical Details of....178
Common Dimensions of Beams and Channels.... 10
Comparison of Gauges....295
 Fractions with Decimals of an Inch....298
 Inches and Fractions with Decimals of a Foot 296-297
 Standard Linear Units ....315
Compound Sections....99-101
Compression Formulae....241-242
Concrete Bars....80-81
Connecting Angles, Location of....127-128
Connections, Beam and Channel....126
 for I-Beams, Details....180
 Limiting Values of Beam....129

# INDEX

PAGE

Conventional Signs for Riveting.....245
Conversion Tables, Metric.....299-305
Corrugated Sheets.....269
Cosecants, Natural.....320-321
Cosines, Natural.....318-319
Cotangents, Natural.....316-317
Cotter Pins.....257
Cube Roots of Numbers.....322-341
Cubes of Numbers.....322-341
Decimals of a Foot, Comparison of Inches and Fractions.....296-297
an Inch, Comparison with Fractions.....298
Definitions of Expressions used in Structural Designing..... 95
Deflection and Bending Moments of Beams.....141-146
Design of Roof.....227-230
Details of I-Beam Bridges.....244
Diagrams of Angles.....26-35
Beams.....11-18
Channels.....19-25
Tees.....36-42
Zees.....43-45
Diamond Bar..... 81
Dimensions of Beams and Channels, Common..... 10
Circular Plates..... 75
Clevis Nuts.....267
Rivet and Bolt Holes.....248
Sheet Piling..... 82
Sleeve Nuts.....266
Turnbuckles.....268
Earth, Slope of Repose and Weights..... 89
Expansion of Bodies by Heat.....287
Water.....287
Expressions Used in Structural Designing..... 95
Fire Box Steel, Standard Specifications for.....360-364
Flat Rolled Steel, Sizes and Weights.....57-70
Floors, Loads for.....243

# INDEX

PAGE

Formulae, Compression....241-242
for Safe Loads for Columns....177
for Stresses for Roof Trusses....231-240
Trigonometrical....312
Foundation Grillages....218-222
Functions of Numbers....322-341
Gauges, Birmingham Wire....294
Comparison of....295
United States Standard for Plate Iron and Steel....293
Girders, Allowable Uniform Loads for....167-175
Plate....223-224
Grillages, Foundation....218-222
Inch, Comparison, with Decimals of a Foot....296-297
Decimals and Fractions Compared....298
Metric Conversion, Tables for....299, 301-303
Inertia, Moments of, Definition.... 95
for Compound Sections....99-101
Rectangles....102-104
Values of....96-98
J & L Offices.... 4
Plants.... 5
Products....6-7
Lateral Pins....257
Lattice Bars and Tie Plates....181
Logarithms of Numbers....322-341
Loads, Allowable Uniform, for Angles....160-162
Beams....147-154
Channels....155-159
Girders....167-175
Tees....163-164
Zees....165-166
for Floors and Roofs....243
on Beams....133-134
Safe, for Columns....182-205
Struts....210-217
for Storage Warehouses....284-286
Wooden Beams....271-280
Posts....281-283

# INDEX

PAGE

Machine Bolts....261
Material, Suggestions for Ordering.... 8
Strength of....291-292
Materials, Specific Gravity of Various....288-290
Weights of Various....284-286
Measure, Comparison of Linear....315
Metals and Alloys, Strength, etc....291
Method of Increasing Sectional Areas.... 9
Metric Conversion Tables....299-305
Linear Units, Comparison with Standard....315
Minimum Rivet Spacing....249-250
Moments of Inertia, Definition.... 95
Method of Finding, for Compound Sections....99-101
of Rectangles....102-104
Values of....96-98
Natural Secants and Cosecants....320-321
Sines and Cosines....318-319
Tangents and Cotangents....316-317
Neutral Axis, Definition.... 95
Numbers, Functions of....322-341
Nuts, Pin and Pilot....256
Clevis....267
Standard....260
Sizes and Weights....262-263
Sleeve....266
Weight of Bolt Heads and....261
Offices, J & L.... 4
Ordering Material, Suggestions for.... 8
Piling, Sheet....82-89
Pilot Nuts....256
Pin Plates, Bearing Values for....259
Pins, Bending Moments....258
Bridge....256
Cotter....257
Lateral....257
Standard Shouldered....255
Stresses in....246

# INDEX

PAGE

Pipe, Weights and Sizes .......... 270
Plane Figures, Areas of .......... 309
Plants, J & L .......... 5
Plate and Angle Columns, Safe Loads .......... 184-193
Plate Girders .......... 223-224
        Allowable Uniform Loads .......... 172-175
    Steel, U. S. Standard Gauge for .......... 293
Plates, Areas of .......... 55-56
    Bearing .......... 132
    Circular, Dimensions and Weights .......... 75-79
    Pin, Bearing Values for .......... 259
    Riveted, Area Deducted for One Hole .......... 247
    Sizes of Universal .......... 71
        Sheared .......... 72-74
    Sketch .......... 75
Posts, Wooden .......... 281-283
Products, J & L .......... 6-7
Properties of Angles .......... 109-119
        Beams .......... 105-106
        Channels .......... 107-108
        Circles .......... 306
        Rails .......... 125
        Sections .......... 95
        Sheet Piling .......... 84-85
        Tees .......... 120-122
        Zees .......... 123-124
Radii of Gyration of Angles .......... 207-209
Radius of Gyration, Definition .......... 95
        Method of Finding for Compound Sections .. 99
Rails, Properties of .......... 125
Reciprocals of Numbers .......... 322-341
Rectangles, Moments of Inertia of .......... 102-104
Reinforcement Bars .......... 80-81
Reinforced Concrete Stresses .......... 292
[illegible]istance of Beams .......... 140

# INDEX

PAGE
Rivet Holes, Spacing and Dimensions....248
Spacing, Minimum....249-250
Riveted Plates, Bars and Angles, Area Deducted for Hole....247
Riveting, Signs for....245
Rivets, Allowable Unit Stress....129
Length for Variant Grips....251
Shearing and Bearing Values....252-253
Stresses in....246
Weight of Round Head....254
Roof Coverings, Weights and Loads....228-229
Design....227-230
Trusses....231-240
Roofs, Safe Loads....243
Round Bars, Sizes....47-48
Weights, Areas and Circumferences....49-54
Safe Loads for Columns....182-205
Formulae for....177
Struts....210-217
Wooden Beams....275
Wooden Posts....281-283
Safe Strength of Struts....206
Screw Ends, Upset....264-265
Threads....260
Secants, Natural....320-321
Sectional Areas, Method of Increasing.... 9
Section Modulus, Definition.... 95
Method of Finding for Compound Sections 99-101
Sections, Compound....99-101
Properties of.... 95
Used as Beams....135-140
Separators, Cast for Beams....130-131
Sheared Plates....72-74
Shearing and Bearing Values of Rivets....252-253
Sheet Piling....82-89
Steel, U. S. Standard Gauge for....293

# INDEX

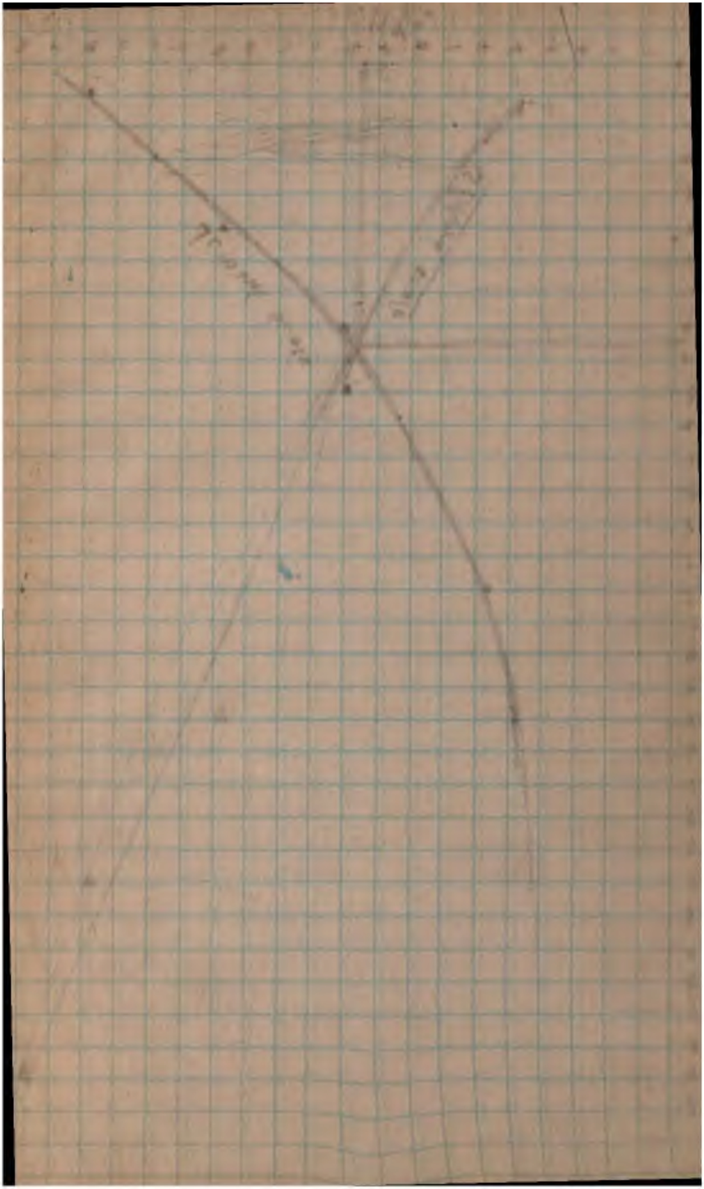
PAGE
Sheets, Corrugated....269
Shouldered Pins....255
Ship Channels, Properties of....108
Sizes and Weights....23-25
Ships, Specifications for Steel for....365-369
Signs for Riveting....245
Sines, Natural....318-319
Sizes of Angles....26-35
Bars....47
Beams....11-18
Chain....91-94
Channels....19-25
Flat Rolled Steel....57-70
Plates....71-79
Tees....36-42
Zees....43-45
Sketch Plates....75
Sleeve Nuts....266
Solids, Surface and Volume of....310-311
Spacing Rivet and Bolt Holes....248
Minimum Rivet....249-250
Specifications for Boiler and Fire Box Steel....360-364
Fabricated Steel Building Construction....370-377
Steel for Bridges....348-353
Buildings....342-347
Castings....354-359
Ships....365-369
Specific Gravity of Various Materials....288-290
Splices, Column, Details of....180
Square Bars, Sizes, Weights and Areas....47-54
Square Roots....322-341
Squares of Numbers....322-341
Steel, Specifications for Boiler and Firebox....360-364
Bridges....348-353
Buildings....342-347
Castings....354-359
Fabricated Building Construction....370-377
Ships....365-369

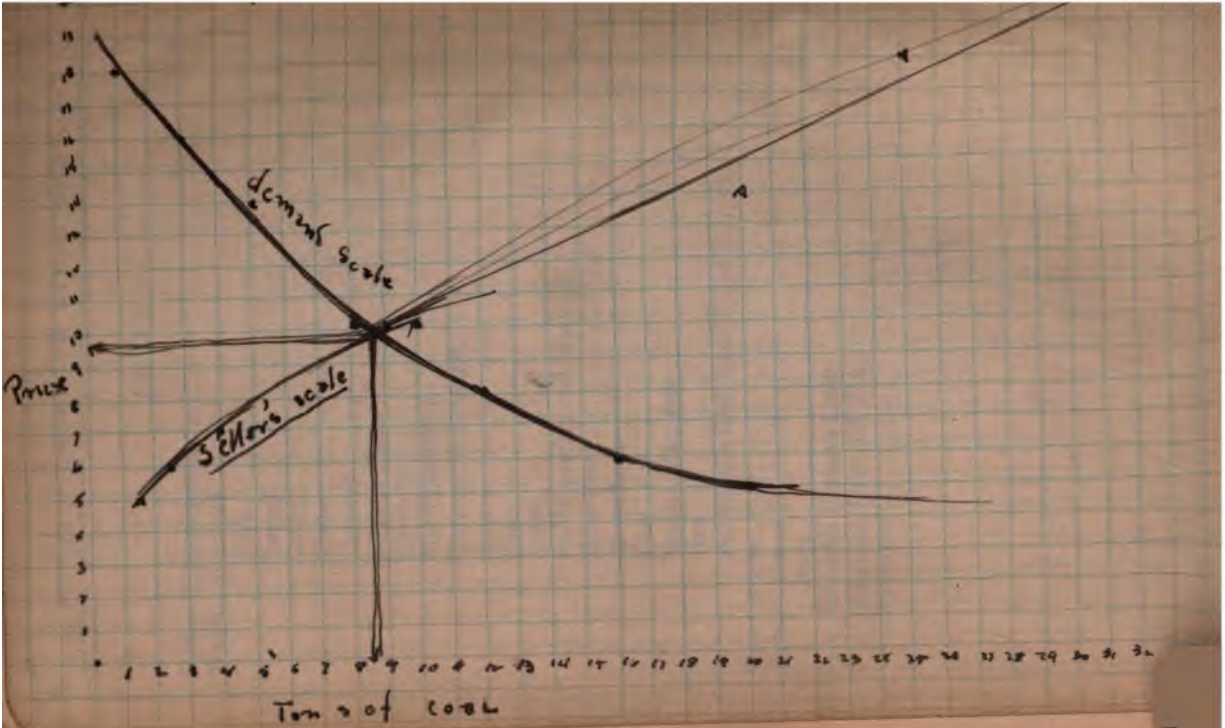
# INDEX

PAGE
Stiffeners for Plate Girders....223-224
Strength of Materials....291-292
Stress, Unit for Comparison of....241-242
Rivets and Bolts....129
Stresses in Rivets and Pins....246
for Trusses....231-240
Various Materials....291-292
Wooden Beams....272-273
Posts....281
Structural Sections Used as Beams....135-140
Struts....176
Radii of Gyration of....207-209
Safe Loads....210-217
Safe Strength....206
Surface of Solids....310-311
Tangents, Natural....316-317
Tees, Allowable Uniform Loads....163-164
Diagrams, Sizes and Weights....36-42
Properties of....120-122
Terra Cotta Arches, Partitions, etc....225
Threads, Standard Screw....260
Tie Plates....181
Tie Rods....226
Triangles, Trigonometrical Solution....313-314
Trigonometrical Formulae....312
Solution of Triangles....313-314
Trusses....231-240
Turnbuckles, Standard....268
United States Standard Gauge for Sheet and Plate Iron and Steel....293
Universal Mill Plates....71
Upset Screw Ends....264-265
Values of Moments of Inertia....96-98
Rivets....252-253
Volume of Solids....310-311
Warehouses, Weights for....284-286

# INDEX

PAGE
Water, Expansion of....287
Weights of Angles....26-35
Bars....49-54
Beams....11-18
Bolts....261
Chain....91-94
Channels....19-25
Circular Plates....76-79
Clevis Nuts....267
Flat Rolled Steel....57-70
Nuts and Bolt Heads....261
Nuts....262-263
Pipe....270
Rivets....254
Roof Covering and Material....228-229
Sheet Piling.... 82
Sleeve Nuts....266
Tees....36-42
Various Materials....284-286
Zees....43-45
and Specific Gravity of Various Materials....288-290
Wire Gauges....294-295
Wooden Beams....271-280
Posts....281-283
Zees, Allowable Uniform Loads....165-166
Diagrams, Sizes and Weights....43-45
Properties of....123-124





Price
demand scale
Seller's scale
A
Tons of coal